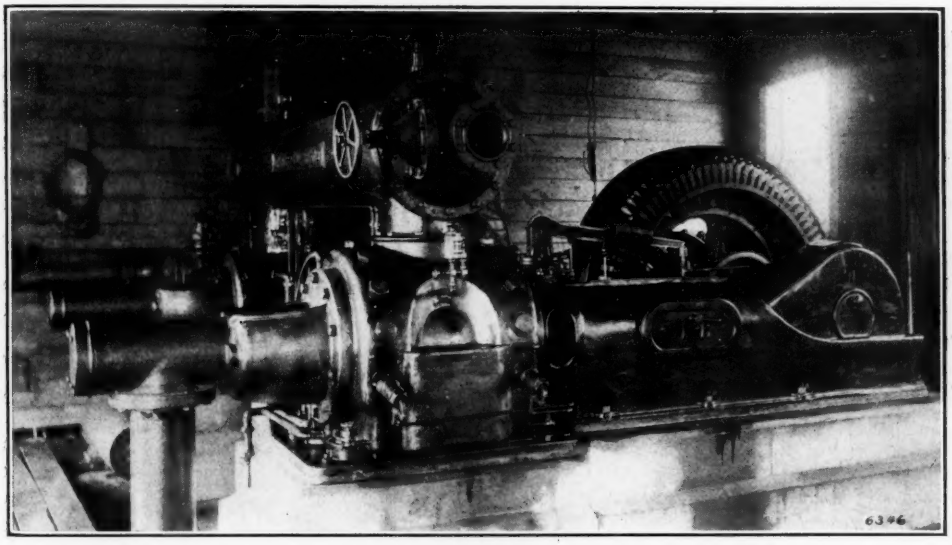
COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVIII FEBRUARY, 1913 No. 2



COMPRESSOR AT WICKWIRE MINE.

RECENT ELECTRIC DRIVES IN IRON MINING

BY C. A. TUPPER.

For several years attempts have been made in iron mining districts to introduce the use of electric power on an extensive scale for the operation of both surface machinery and underground equipment, beginning usually with the pumps, compressors and hoists. The progress made, however, has not been what might have been expected from the success of the electric drive in other industrial fields. This has been due mainly to the peculiar problems involved, which vary radically for each class of equipment.

At first the attempt was invariably made to take existing types, including both the driven machines and the motors, and to couple up the two for operation—whether directly, with gearing, or through belting—without much regard to the particular characteristics of either. The results were in most cases very unsatisfactory and delayed for a considerable time the actual electrification of many important properties.

Gradually it became apparent to manufacturers and users of mining machinery, the same as it had earlier to operators in the metal working field, that what was needed was the practical redesigning of both driven machines and motors, and to a considerable extent the introduction of much higher speeds to meet the exacting conditions of mining service.

Among the various problems presented, that of electrically operated air compressors has been prominent, and during a recent trip over the northern iron ranges the writer was greatly interested in observing the progress made there within the past year.

One of the pioneers in bringing about the new order of things is the Cleveland-Cliffs Iron Co., but examples of equal interest are to be found in the Iron river district of the Menominee range, where several motor-driven compressors of the larger capacities recently were placed in service. The first of these plants visited by the writer were those of the Wickwire Mining Co., at the Wickwire and Cortland mines, Iron Range, Mich., the details of which are decidedly instructive.

The compressor installed at the Wickwire mine is an Ingersoll-Rand P. E. 2, two-stage machine, having air cylinders 18¼ inches and 11¼ inches in diameter by 16-inch stroke. At 225 revolutions per minute it delivers 995 cubic feet of free air per minute, the receiver pressure being 100 pounds. The writer was chiefly interested, at the start, in considering this unit from the standpoint of compressor design, and will, therefore, take up the various basic features of construction before entering upon the auxiliary details which form part of the operation of the plant as a whole.

The first feature to attract attention in a high speed compressor of this type, even from superficial observation, is that the frame on each is of the unit, heavy-duty engine design, supported for its entire length on the foundation, while the cylinders, resting on sole plates, are made with a full box underneath instead of a foot. The whole of this box is a part of the water jacket and serves as a settling chamber. Next, it is noted that the compressor is accessible, both inside and outside. At the driving end are the main bearings, of the three-part pattern, in which a film of oil is constantly maintained between the shaft and the babbitted shells. On the sides are the cranks, cross-heads and connecting rods. These are accessible, while the machine is in operation, through the front and top doors on the oil guards and through a large door on the side of the main frame. The air pistons can be withdrawn at the back.

The air cylinders, cooling system and method of lubrication have also a story of interest for the close observer. The hurricane piston inlet valve is employed for the air intake of both valves. This ingenious and efficient device it is not necessary to describe here. The discharge valves are of the cushioned, direct lift type. These valves are arranged radially in the cylinder and seat directly on the metal of the barrel, thus not only rendering any removable valve seats unnecessary, but also leaving the head free to be completely water jacketed.

The system of lubrication is particularly effective. It provides for delivering a constant stream of oil to the main bearings, crank pins and crosshead pins. The flow of oil begins as the machine starts and its delivery is automatically proportioned to the speed. For lubricating the air cylinders, where a minimum of oil is required, adjustable sight feed lubricators are provided.

THE MOTOR.

The design of this machine, as a cross-compound compressor, lent itself admirably to the electric drive, the motor being placed between the main bearings with the rotor pressed and keyed on the shaft. This was a Westinghouse synchronous motor of 170 horse power capacity, operating on three-phase, 60 cycle, alternating current at 2,200 volts.

The Wickwire mine appears to be partially drained through other properties. It makes about 200 gallons of water per minute. This quantity was handled by a No. 8 Cameron pump of 150 gallons rated capacity, but to provide for the increased volume of water which will result from the further opening of the mine, the management installed a Buffalo Steam Pump Co.'s two-stage, 3-inch centrifugal unit of 300 gallons delivery per minute, against a head of 119 feet. This is driven by a 35 horse power, 1,200 revolutions per minute, General Electric synchronous motor.

The water pumped from the Wickwire mine is first discharged into a cylindrical tank outside the power house. From this it flows through piping to the compressor where it enters the bottom of the low pressure cylinder head, passes out at the top, and thence to the bottom of each end of the cylinder, to the top of the water space. From the low pressure side of the compressor the water circulation continues on through the intercooler, which is set transversely above and connects the air cylinders. From the compressor jackets and the intercooler the stream of cooling water

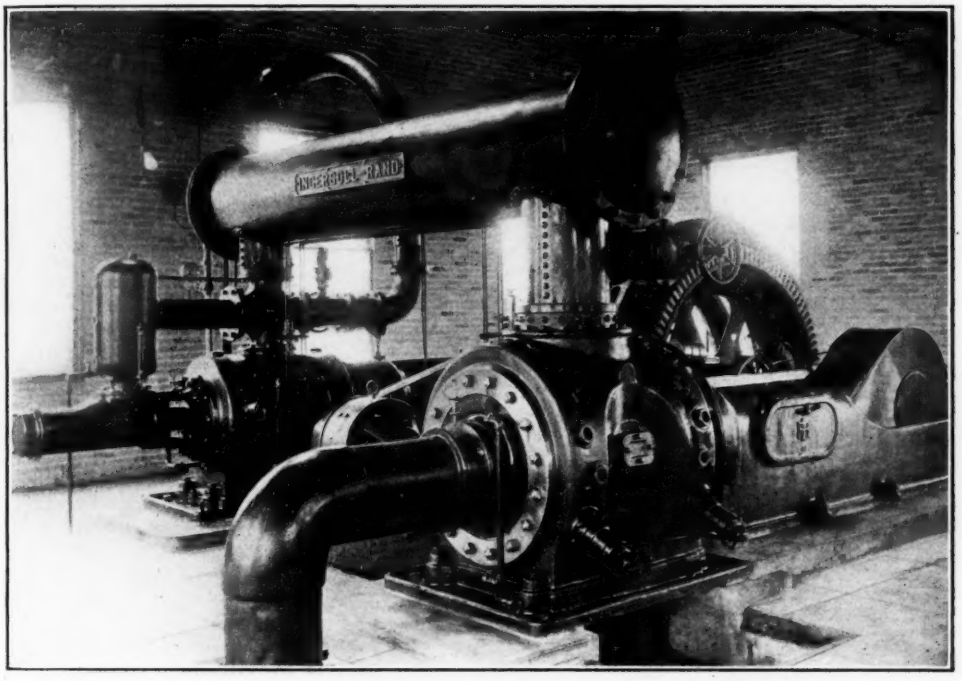
flows to a wooden tank and is fed by an injector to the boilers.

The electric power used in the Wickwire and Cortland mines is purchased from the Peninsular Power Co. at the very low rate of 1 cent per kilowatt-hour, or higher if 60 per cent. load factor is not maintained. Current comes in at 6,600 volts, and is stepped down to 2,200 volts at the Wickwire mine, by three Westinghouse 125-kilovolt-ampere, oil-cooled transformers, at the same time being measured by a Thompson high torque wattmeter. The incoming lines are equipped with a Westinghouse lightning arrester, and are controlled from a panel fitted with Westinghouse apparatus. There is a Westinghouse switchboard for the 170-horsepower motor driving the compressor and its 6-kilowatt exciter.

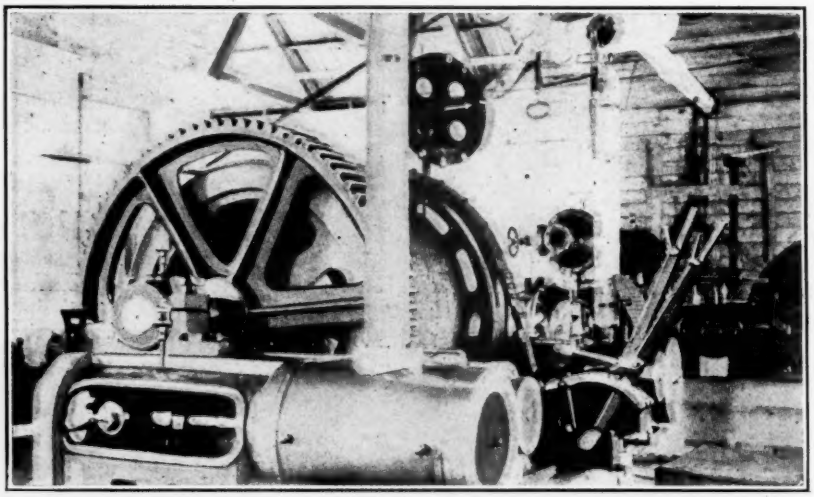
At the Cortland mine the compressor is also an Ingersoll-Rand machine, driven by a Westinghouse motor of the same design as the above, but larger, being 12½ and 21¼x18 inches. It supplies 1,352 cubic feet of free air per minute at 200 revolutions per minute. The motor is rated at 200 horsepower with a 5-kilowatt exciter. The hoist is run by compressed air. The arrangement of the incoming electric line is similar to that described. There are three, 125-kilovolt-ampere Westinghouse 2,200-220-volt transformers, lightning arrester and the necessary switchboard panels.

REGULATION OF THE COMPRESSORS.

Regulation of the compressors at the Wickwire and Cortland mines is effected in five stages—full load, three-quarter load, one-half load, one-quarter load and no load—by means of an automatic clearance controller. This consists of a number of clearance pockets which are thrown automatically into communication with the ends of each air cylinder in proper succession, according to a pre-determined variation in receiver pressure. With the compressor operating at partial capacity, a portion of the air is compressed into added clearance space instead of passing through the discharge valves. On the return stroke this air expands, giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure. The inlet valve then opens, and free air is admitted to the cylinder for the remainder of the return stroke. Thus the inlet capacity



COMPRESSOR AT CORTLAND MINE.



AIR DRIVEN HOISTING ENGINE.

of the compressor is lowered without reducing the intake pressure. The Wickwire Mining Co.'s units being each two-stage machines, clearance space in the proper proportion is added simultaneously to both low and high pressure cylinders, thus maintaining a constant ratio of compression over the entire load range. This system of regulation is a very desirable one under conditions, such as those above mentioned, where electric power is purchased on the basis of a special maximum demand charge, as it permits the motor to be operated at a higher load factor than would otherwise be possible.

To further eliminate the necessity for peaks and hollows in its load curve, the company contemplates constructing an underground chamber, below the mine sump, for storage of air, utilizing a column of water to give the effect of a hydraulic accumulator. This will enable the compressor to be run at constant speed, under practically ideal conditions of efficiency, and the hoist can then be operated by air, admitted to its cylinders, instead of steam, in a manner similar to those of the Oliver Iron Mining Co. at Iron Mountain, Mich., where compressed air is piped in from a distant plant operated by water power.

DAVIDSON COMPRESSOR STATION.

Following the inspection of the Wickwire Mining Co.'s plant, the writer visited the new compressor station of the Davidson Ore Mining Co., north of Iron river, where the compressor is an Ingersoll-Rand P. E. machine of much larger capacity, having a delivery of 2,500 cubic feet per minute.

The compressor at the Davidson mine, a unit similar to which will shortly be put in service at the Bengal mine, Palatka, Mich., of the Verona Mining Co., is driven by a Westinghouse synchronous motor of 400 horespower capacity, 2,200 volts, at 150 revolutions per minute, with a 10-kilowatt exciter. Current from the Peninsular Power Co.'s mains is received through three 125-kilovolt-ampere, oil-cooled, Westinghouse transformers, and the circuit is protected by a Westinghouse lightning arrester. The usual switchboard and other auxiliary apparatus have been installed.

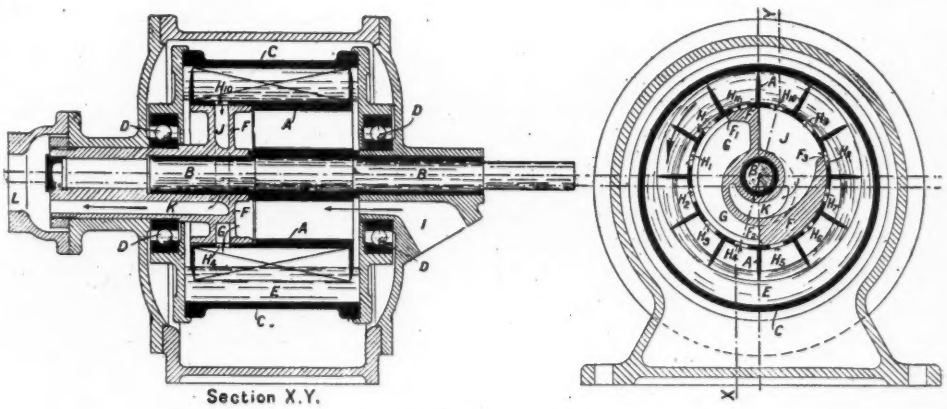
USE OF SYNCHRONOUS MOTOR

In the decision of various mining companies to adopt electrically-driven compressors, the use of the synchronous motor and its characteristic of building-up or equalizing the power factor of the system has played a leading part.

A synchronous motor will operate at any desired power factor. Varying the strength of the direct current exciting the field magnets, which can readily be done by an attendant while the machine is running, will cause a variation in the power factor. In this manner it cannot only be raised to any degree, but can be made to neutralize the effect of other apparatus having a lower power factor, thus bringing the value in the main transmission line and on the generator up to 100 per cent.

irrespective of the deficiency in this respect of other apparatus.

The synchronous motor can be constructed to operate equally well on single phase, two-phase or three-phase circuits, with, of course, the proper winding in each case. When its fields are fully excited and it has been brought up to its rated speed, which can be done by a small induction or direct current motor mounted on the same shaft, or by a special winding on the rotor, current can be thrown on from the main supply as soon as synchronism is indicated by lamps or by a suitable instrument on the starting panel. Then, provided the speed of the main generator is suitably regulated, this type of motor will run at absolutely constant speed from no load up to a very heavy overload. Its use is generally restricted to a special service and large units, such as those described, owing to the fact that a direct current exciter must be provided and that in its simpler forms it is not self-starting, even under no load; but for the conditions of compressor service mentioned, it is practically an ideal machine, and its application in this direction is being rapidly extended.



EISERMANN-LEHNE BLOWER.

A NEW BLOWER

We have lately had brought to our notice a new and ingenious type of blower which is the invention of two German engineers, Herr Rudolf Eisermann and Josef Lehne, whose English patent No. 8104 of 1912 is now owned by the Internationale Rotations-Maschinengesellschaft m.b.h., of Berlin. The invention relates to bucket-wheel or blade-wheel pumps in general and in particular to blade wheel pumps for pumping gases. The essence of the invention consists in the blade wheel being arranged in a freely revolvable drum, which is mounted eccentrically with regard to the blade wheel and which is intended for the reception of a working fluid.

The apparatus will be readily understood by the aid of the accompanying engraving, the drawing on the left hand of which is a section on the line X Y in the righthand view. It will be seen that a star or blade wheel A is carried on a shaft B and is revolved by it. The star wheel is mounted eccentrically inside the closed casing C, which revolves with very slight friction owing to its being provided with the ball bearings D. The casing is watertight and it contains the working liquid E, which, may be, say, water. The effect of revolving the blade wheel is to set the water in motion, and very soon after the blade wheel has been started the whole volume of water is revolving and is thrown out by centrifugal force against the internal periphery of the casing. The effect of the friction between the water and the casing is to cause the latter to revolve, which it does, we are informed, almost as soon as the star wheel is started, its speed gradually rising until it is practically the same as that of the water. When this condition has been reached the working liquid is by the action of centrifugal force made to form a ring of equal depth all the way round the inside of the casing, the depth of liquid being just sufficient to form a seal at the top of the star wheel as seen in the right-hand view in the drawing.

One end of the wheel A just fits over and

can revolve on a fixed dividing piece F which has several functions. The gas which it is proposed to compress or pump is allowed to enter the apparatus through the passage I, which is in direct communication with the passage G in the dividing piece F. The star wheel A has a number of slots or ports—H, H_1, H_2 ... H_{11}—in its periphery in the centres of the parts coming between the blades. It will be seen in the right-hand section that as the gas to be dealt with is in the passage G it will pass through the ports H, H_1, H_2, H_3, and H_4 and will fill the compartments formed between the blades of the wheel and the surface of the ring of working liquid. As soon as by the revolution of the wheel any one of the ports—in this case H_5—has been covered by the lip F_2 of the dividing piece F no further gas can enter that particular compartment. Nor can any gas escape from this or the two compartments immediately in front of it. In the case of the third compartment from H_5, that is to say, in H_8, matters are different, for the port has been uncovered by its passing beyond the lip F_3.

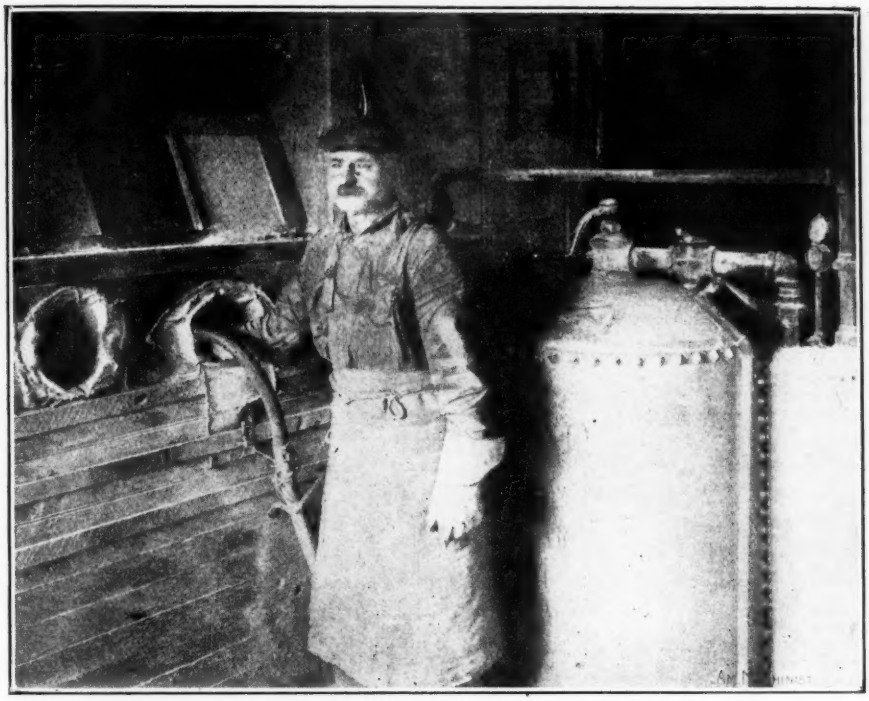
The result will be readily understood. It will be observed that as the wheel keeps on revolving the size of each successive compartment is gradually decreased, so that the gas when it escapes into the receiving chamber J through the port H_8 is considerably compressed, and compressed gas also escapes into J through the ports H_9 and H_{10}. By reason of the liquid seal, which has already been referred to as existing at the top of the star wheel, no compressed gas can leak past from J to G and no free gas can get through the port H_{11} until it is uncovered by traveling past the lip F_1. The compressed gas receiving chamber J is in communication with the passage K which leads to the discharge nozzle L of the apparatus.

The whole thing is wonderfully simple, and we understand that it works well. We gather that tests made with a blower having a star wheel 3¼ inches in internal diameter and 2¼ inches in width have shown a pressure above that of the atmosphere of about 20 pounds per square inch with the delivery pipe completely closed and with the wheel revolving at a speed of 3,600 revolutions per minute; while at the same speed and with the suction aperture closed a vacuum of about 24 inches of mercury was obtained. In some further tests, of which the makers have given us particulars, the pressures were taken up to an equivalent of a column of 16 inches of mercury, the volume of air delivered being carefully measured. The efficiency under these conditions was about 70 per cent. The efficiency when producing a vacuum is given as being about 60 per cent. With larger machines we are informed that pressures up to 30 pounds per square inch and a vacuum of 95 per cent. of that theoretically possible have been obtained.

The blowers can be made to work with the spindles vertical as well as horizontal. It is claimed for the apparatus that the losses due to jerks and liquid friction, which are large in many kinds of blowers of this type, are minimised, and that the principal losses, which result in other machines from the fact that the greater part of the energy communicated to the working liquid is wasted and has to be continuously replaced in the working of the cycle, are very nearly entirely done away with. When once the inertia of the water and the casing is overcome but little energy is required to keep them both revolving.—*The Engineer, London.*

VARIOUS WATERS

Rain-water collected after a long period of wet weather is the purest natural water. It contains atmospheric air and gases in the proportion of about 2.5 cubic inches to every 100 cubic inches of water. River water is the next purest, then comes the water of lakes, ponds, ordinary springs and mineral springs. Following these waters come arms of the ocean lying in the vicinity of the mouth or discharge of great rivers, then follows the water of the main ocean and last of all the waters of lakes, like the Dead Sea, Caspian Sea, and the salt lakes of Utah. Spring water although perfectly transparent contains more or less mineral matter dissolved in it. The nature of these impurities will depend on the character of the soil through which the water percolates. The most general impurities are carbonate of lime, common salt, sulphate of lime (sometimes called gypsum), sulphate and carbonate of Magnesia and compounds of iron. Most spring waters contain a certain proportion of carbonic acid gas.



OPERATOR WELL PROTECTED.

TO PROTECT THE SANDBLAST OPERATOR

The half tone here reproduced from the *American Machinist* shows an arrangement in use at the plant of the New Process Raw Hide Company, Syracuse, N. Y. The sandblast apparatus is in a detached building, which is divided into two rooms. The large one, seen in the illustration, has the sand-storage bins, separator and sandblast machinery. The smaller is the working room where the cleaning is done. The operator is in the outer room as shown, which is free from flying dust. He puts his arms through the holes in the partition which encloses the smaller room, these holes being protected by canvas flaps to keep sand from blowing back through them. At a convenient height for the operator's eyes is a three-pane sash through which he can look and see the work going on inside. The work is mostly small pieces that are easily handled on a table set at a convenient height to be reached by the workman's hands. An interesting point is the sandblasting of the glass through which he looks. This cuts so rapidly that a new pane must be put in for each day's run.

TESTS OF A TURBO COMPRESSOR

Descriptions and data of tests of a turbo-compressor plant at the Westerholt mine, Ruhr district, Prussia, have recently been published in *Glückauf*. The turbine driving the compressor is so arranged as to be able to work both with live and exhaust steam, while the compressor can take in either 10,000 cbm (say 35,000 cu. ft.) of air per hour and compress it to 6 atmospheres, itself running at 4,400 r.p.m., or it can run at 4,200 r.p.m., and compress to 5.5 atmospheres, 5,000 cbm of outside air. The consumpton of steam was guaranteed to be: for exhaust steam only, when handling 10,000 cbm, 1.4 kg/cbm (say 0.04 lb. per cu. ft.), for 5,000 cbm, 1.78 kg/cbm (say 0.051 lb. per cu. ft.); for live steam only 0.69 kg/cbm and 0.88 (say 0.02 and 0.025 lb. per cu. ft.) for the full and half load respectively. The actual test values are slightly more favorable than these. The article contains full data of the test.

VARIOUS PNEUMATIC DEVICES

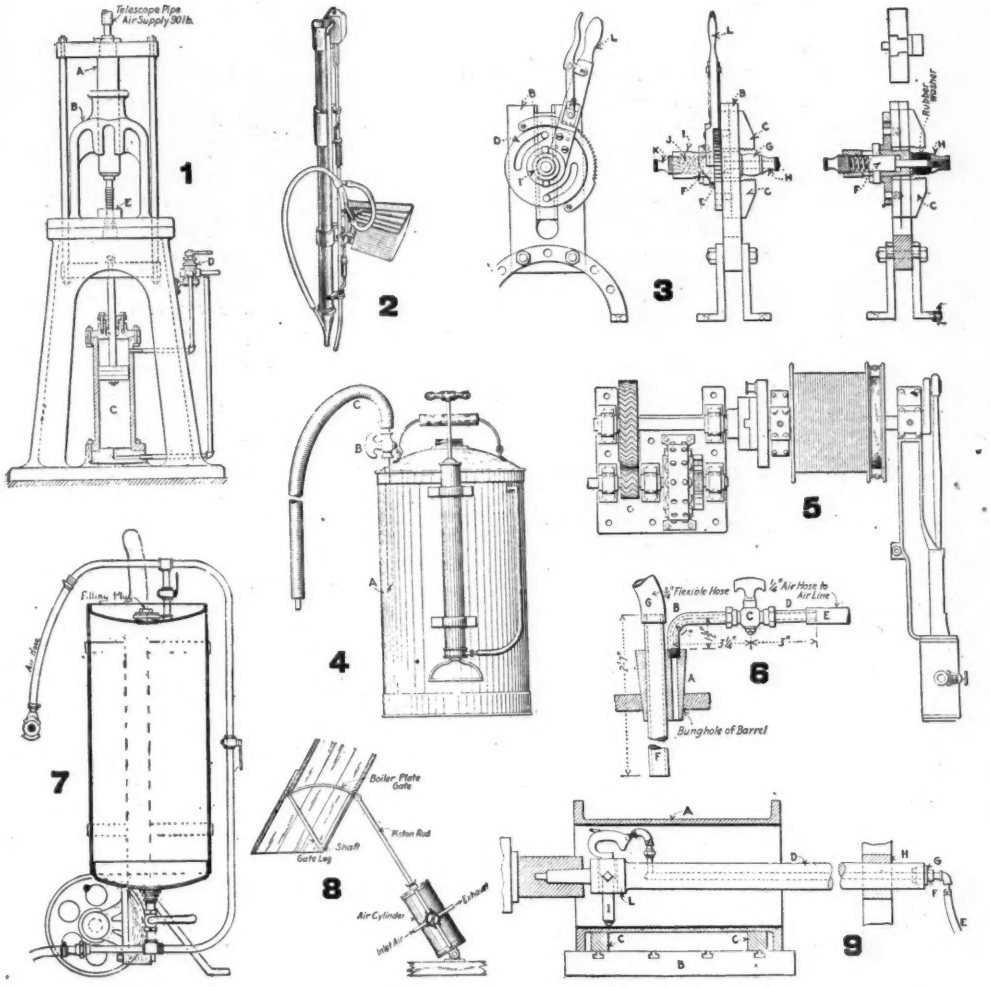
In the cut on the opposite page are grouped sketches from various sources of a number of devices such as are continually developing wherever a supply of compressed air exists, and especially when active brains acquire the habit of thinking compressed air.

Fig. 1, from the *American Machinist,* shows how a pneumatic hammer was used as a broaching tool. The hammer does not differ from ordinary tools of this type except that it is made heavier, as the extra weight helps to keep it down to the work. In operation the hammer A is raised to the top of the guide frame B by means of the piston in cylinder C and its connecting side rods extending to the top, the air for operating this piston being controlled by the four-way valve D. The broaching tool is inserted in the work E, and the hammer brought down on it by reversing the four-way valve and introducing pressure above the piston in the cylinder. The air pressure is then admitted to the hammer by means of a valve (not shown) operated by a pedal. As the hammer drives the broach through the work, it is kept down to its work by the pressure on the cylinder, thereby increasing the force of the blow by eliminating all rebound. The work shown is tool steel 2½ in. in diameter, 1 in. thick and has a $1^{1}/_{16}$-in. square hole with corners rounding $^{1}/_{16}$-in. radius. It is done in one operation with a broach 14 in. long.

Fig. 2 is a pneumatic nail-driving hammer, particularly designed for use by carpenters in nailing laths. Attached to the tube containing the piston or hammer is a nail box or hopper having a capacity of about 250 nails. The vibrating of this hopper causes the nails to be tripped up and forced, one at a time, into a rubber tube, through which they are forced to the head of the hammer by the compressed air. Protruding slightly over the head of the hammer is a trip rod which, when forced against the wall or object to be nailed, allows the nail to be set in the hammer head, and also releases the trigger which allows the compressed air to pass into the power chamber. The piston rod, striking the hammer, then drives the nail home. The weight of the hammer is about 3½ lb., and a speed of 100 nails a minute can be attained.

Fig. 3, from the *American Machinist,* shows an air-hose testing device produced for the Canadian Pacific Ry., Angus Shops, Montreal, for holding the threaded end of air hose while testing it under air pressure. It consists of the upright piece *B* slotted down the center to receive the hardened tool-steel jaws *C*. The gripping faces of the jaws are threaded to correspond to the threads on the air-hose connection. The jaws also have two studs screwed in at the back, which project into slots cut in the cam plate *D*. This cam plate also carries the double-rise cam *E*, thus serving the double purpose of closing the jaws and drawing in the bolt *EF*, which compresses the rubber washer *G* lengthwise, causing it to expand radially. An adjusting nut *H* is screwed on the bolt *F*. The sleeve *I* is screwed into the center of the body and holds the cam in position; it also holds the bolt *F*, the spring *J* and the guide plug *K*. It has two slots on opposite sides which allow the passage of the pin intersecting the large end of the bolt *F*, and on which the cam *E* acts to draw in the bolt *F*. The action of the lever *L* and the method of locking it in various positions on the ratchet, are obvious. The brackets holding the device are so made that the device may be set at whatever angle is most convenient for the operator. In operation the air-hose connection is slipped over the rubber washer *G* and between the two jaws. The lever is pulled down, closing the jaws on the threaded end of the connection while the rubber washer is expanded inside the connection, making it airtight, and at the same time holding it firmly, while the air is applied to the other end. Soapy water is put over the hose to detect any air leakage.

Fig. 4, from *Power,* shows a can for taking up oil from places difficult of access in the usual way. The can is the ordinary galvanized, 5-gal. size and the pump is of the bicycle variety with a leather plunger. A metal valve stem is soldered on the bottom end in place of the hose connection found on the pump. To the valve stem or check valve, is attached a small rubber hose, the other end of which is connected to the top of the can. A small pipe *A* is soldered on the top of the can, to which is attached a small petcock *B* and a piece of rubber hose *C*. Gaskets should be placed under the caps on top of the can to make them airtight. A few strokes of the pump removes the air from the can, whereupon, by placing the end of hose in the oil to be canned, and opening the cock, the oil flows into the can.



VARIOUS PNEUMATIC DEVICES.

Fig. 5 also is from *Power* and illustrates the following: At a certain mine compressed air is used to operate the brake on a single-drum, direct-motion, Corliss winding engine handling but one cage for elevating men from the mine 1,000 ft. below the surface. The engine had originally been steam-driven, having two 18x48-in. high-pressure cylinders. An 8-ft. drum was mounted on the shaft. The engine has been remodeled and is now driven by a 720-hp. geared motor. The gear teeth are of the double-herringbone type and have a ratio of 4.5 to 1. The pinion is made of nickel steel and the spur wheel of cast steel, the shaft of which couples direct to the drum shaft by a "ham" coupling. One cylinder of the engine is used, the crosshead and connecting-rod being coupled to the crank. On the coupling side of the drum the crank has been removed and a crank disk substituted which contains the male side of the coupling. In lowering the men, the post brake is released and the cage descends of its own weight to the bottom of the shaft. While the rope and drum are paying out the steam cylinder is turned into an air compressor, as the valve-gear is still on the cylinder side and the reversing link is set against the engine. The exhaust valves therefore are the admission valves and the former admission valves are

the exhaust valves. The air is compressed against a special relief valve under the operators' platform, which is operated by a lever. The operator controls the speed of the drum by opening and closing this relief valve, reducing or increasing the air pressure against the engine piston.

Fig. 6 shows a device employing compressed air for transferring oil from barrels to storage tanks. A castiron plug A is made to fit the bung hole of the barrel, a ¼-in. air pipe B is tapped into the top of the plug and a ¼ in. air valve C is screwed on this air pipe. A short nipple *D* and a ¼-in. air hose *E* are secured on the end of the nipple and connected to the main air line. The hose should be long enough for the device to be moved from tank to tank. A ¾-in. standpipe *F* should slide snugly through the cast-iron plug so no oil can escape. On the end of the ¾-in. pipe is a ¾-in. flexible hose *G* long enough to reach the inlet of the tank. Roll the barrel near the tank, take out the barrel plug and insert the cast-iron plug by giving a few taps with a hammer so as to make a tight fit, force the ¾-in. pipe to the bottom of the barrel, connect the flexible hose to the tank, turn on the air, and in a few minutes the barrel will be empty.

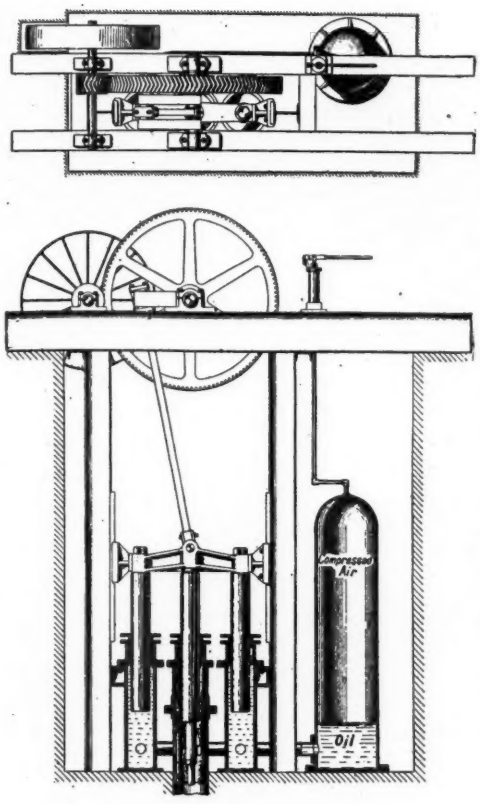
Fig. 7, from *Railway and Locomotive Engineering*, shows a sand blast machine cheaply made in a railroad repair shop. It has proved itself very useful in sand blasting tenders that are badly pitted. This machine does rapid and good work and, of course, its operations are best suited for the open air. As shown in the illustration, the apparatus is portable, and the hose attachment may be lengthened to suit any condition. The nozzle may be made of brass and the opening need not be more than one-quarter of an inch in diameter at the point, and tapering inwardly for four inches to a diameter of half an inch. The socket and other attachments should be free from sharp corners. A machine of this kind is not only easily made, but will speedily pay for itself.

Fig. 8, from *Engineering and Mining Journal*, shows a pneumatically operated ore chute door in use at the Cactus mine of South Utah Mines and Smelters, Beaver County, Utah. The door is operated by moving a lever controlling a four-way valve. The advantage of this gate is that the weight of the ore bears directly on the shaft so that the power required in opening and closing is less than in the old style of drop gate. The closing is positive and ore is not spilled on account of rock getting under the gate and preventing its total closure. To the bottom corner of the chute is attached the supporting shaft. The door is constructed of a square sheet of boiler plate the width of the chute, bent in an arc with the face up, and supported on the shaft by two legs, so as to revolve about the shaft as an axis. To the side of the door which is on the underside of the chute, is attached a piston working in a cylinder. The piston rod is hinged at top and the cylinder at bottom so as to allow the necessary play. The air pipe parts at a four-way valve and the air enters the cylinder from top and bottom.

Fig. 9, from *American Machinist*, is perhaps the most interesting of the group of devices here shown. The cylinder A was lined with babbit and it was required that the entire surface should be peened or hammered to make it compact before boring. The cylinder was mounted upon the table of a horizontal boring mill, and the pneumatic hammer was mounted near the end of a special rotating bar. The air was conveyed to the hammer through the center of the bar and controlled by a valve, not shown, with which the hose connected. The bar was rotated slowly, the hammer delivering its rapid blows, and the table with the cylinder was fed along until the hammer reached the other end and the job was done.

THE FARMER'S BLOWER

The old stump puller is no more, the dynamiting of stumps is not a great success, and now the rotary blower is trying it. A small portable gasolene engine of one or two horsepower is used to drive a blower, from which pipe lines are run to various stumps. A portion of the earth is dug away from a stump, a fire is started, and when well under way a blast of air by one of the pipes is directed against it, and in a short time the stump, with roots included, is entirely consumed. A 14-inch blower will supply air for at least 6, and in most cases 8 and even 10 stumps. This outfit will clear under average conditions over half an acre per day and at a cost not exceeding $5, which includes cost of gasoline, labor and other items of expense.



A COUNTER BALANCED DEEP-WELL PUMP

The cut here reproduced from The Engineer, London, shows a pneumatically and hydraulically balanced well pump recently installed in some English mines. One of these pumps is at present operating an 8 in. deep well and is working on a total water lift of 350 ft., 320 ft. being below the surface and 30 ft. above. It is electrically driven and has been running now continuously night and day, Sundays included, since September, 1911. A second pump has a similar water lift, while a third is of a larger capacity than either of the foregoing, being designed to raise 12,000 gallons of water per hour on a lift of 250 ft. below and about 30 ft. above surface level.

The top portion of the pump is operated by a crank driven by helical gears. The motive power can, of course, be applied direct or through a belt. The single crank operates, by means of a connecting-rod, a cast iron crosshead which works in adjustable slipper guides. To this crosshead are attached three plungers, of which that in the centre works a tier of pump rods.

The two side rams work through stuffing-boxes fitted with metallic packing, the pressure on the rams being maintained by a cylinder filled with compressed air, there being the necessary connecting pipe between the plunger barrels and the cylinder. In order to obtain a seal the lower portion of the cylinder is—as will be observed in the engraving—filled with oil.

By means of this arrangement a variable counterbalance can be obtained to suit exactly the pumping water level, this being brought about by varying the air pressure in the cylinder. The advantages which are claimed for this system of counterbalancing are as follows:—(1) Silence in working; (2) the obviating of wear and tear in the working parts; (3) adjustability of counterbalance by a variation of air pressure; (4) the relieving of the crank shaft of over half the weight, as half the pull of the pump is taken up by the plungers, the weight of which is all carried on the floor or bottom of the pit; (5) even turning moment, the variation of speed when passing over the top and bottom centres being eliminated; consequently (6) elimination of back lash in the gear wheels; and (7) that owing to there being a certain amount of thrust on the down stroke the work is considerably more even on all the bearings than is usually the case, the load on the crank shaft being equalized during the complete revolution.

It has been found in practice that the air in the air vessel requires only a few strokes of the compressor about once a week to maintain the required pressure, while, owing to the type of packing employed, the oil only requires replenishing about once a year.

OUR COAL

The known coal area in the United States covers 310,000 square miles, and there are 160,000 square miles additional which may contain marketable coals and 32,000 square miles which are not available. The original content of these coal measures is estimated

at 3,076,204,000,000 short tons, of which 1,922,979,000,000 short tons are easily accesible; 1,153,225,000,000 short tons are accessible with difficulty. The production from these coal measures to the end of 1911 was 2,270,798,737 short tons of anthracite and 6,468,773,690 short tons of bituminous, an aggregate of 8,739,572,427 short tons. This production represents an exhaustion of the coal beds equal to 14,181,890,000 short tons, or a little less than 0.5 per cent. of the original supply. The quantity of coal yet available for mining is 3,062,022,020,000 short tons, or about 99.5 per cent. of the original supply.

CARE AND LUBRICATION OF AIR COMPRESSORS

The following has been prepared by Mr. James L. Davidson, Secretary of the Alabama Coal Operators Association, under the approval and direction of the Mine Casualty and Mining Institute Committee.

Having noticed in the Alabama Supreme Court Reporter a decision, awarding heavy damages to the Administrators of a man killed in the mines by gas from the exhaust of a compressed air driven pump, when he went to start up the pump; the Secretary takes the liberty of giving you the following information, gathered from reliable sources, in regard to the care and operation of Air Compressors, with respect to safety and efficiency, viz.:

It is a fact that Air Compressors frequently pollute the mine air with dangerous gases, and sometimes explode, causing damage to persons and property. In either case the same may be generally attributed to the excessive heating in the presence of compressed air of the oil and foreign substances that have collected in the cylinder, discharge pipes and air passages and especially in and around the valves. Volatilization and ignition of oil and other carbonaceous matter occur very rapidly in the presence of highly heated air.

The greatest heating takes place where the air passes from the cylinder into the discharge pipe.

Even though the compressor is equipped with modern and approved cooling devices, insufficiency of size or too many angles in the discharge pipe, or incrustation of dust mixed with oil, at the discharge opening, decreasing the capacity of the discharge any or all of them may produce enough heat to cause an explosion, or anyway, produce dangerous gases, which should not enter the mine.

TWO IMPORTANT THINGS.

It is therefore, important:

First—To Keep the Compressed Air While Being Compressed, At As Low A Temperature As Possible.

Second—To Prevent Oil and Other Carbonaceous Substances From Collecting in Any Part of the Machine Or in the Discharge Pipes.

All ports and air passages should be as large as practicable and should be kept free from obstructions and incrustations. In addition to partly closing the ports, incrustation often causes the valves to stick, resulting in disastrous consequences. When the valves stick it causes a "Back kick" and considerable friction in re-compression, which produces great heat.

To avoid incrustation and collecting of oil and foreign substances in the machine and discharge pipes, high-grade non-carbonizing oil may be used and should be properly fed into the cylinder. Petroleum oil, especially free from volatile carbon, with flash point of not less than 625 degrees F. is recommended. The oil should not be too dense nor contain animal or vegetable oil. Do not in any case, use ordinary steam cylinder oil. Why? Because the heat in the Steam Cylinder is moist, and the surplus oil is washed out, whereas, the heat in the Compressor Cylinder is dry, thus causing the oil to stick and cake. For the above reason, and also on account of the difference in the character of the proper lubricant and the work it has to perform, the proper feeding of oil, to the compressor cylinder, is very different from the oil feed to a Steam Cylinder. Too much oil causes incrustation. A surprisingly small quantity of good oil will give sufficient lubrication to air compressors. Watch your compressor and cut the amount of oil down to the minimum of its requirements. Oil should not be allowed to collect in the machine. In case it does, it should not be allowed to remain, but should be drawn off immediately.

Even when using the best oil, properly

fed to the cylinder, the machine should be cleaned frequently or when needed.

DON'T USE KEROSENE.

Do not use kerosene for cleaning! It is very dangerous. Kerosene has a flash point of about 120 degrees F. and the temperature of the compressed air may at any time reach 300 to 450 degrees F. and cause an explosion. The best and safest method of cleaning is to feed into the air cylinder, soapsuds, made of one part soft soap, to 15 parts clean water. Feed a liberal amount of this solution into the cylinder instead of the oil for a few hours or even for a day, if necessary. The accumulation of this water and oil should be drained off from time to time during the process by opening the blow off valve at the receiver.

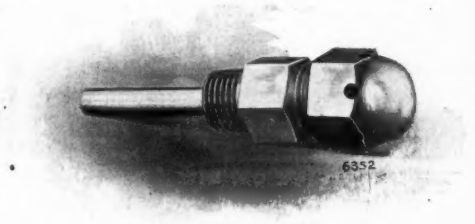
To prevent rusting, it is necessary to run the machine and feed oil into the cylinder for an hour or so after the cleaning process is completed and the water drained off, so that the valves and all parts connected with the cylinder will become coated with oil before shutting down the machine.

The temperature of the discharged air should never exceed 250 degrees F.. The machine should be watched and if the temperature exceeds the above, it should be shut down and cooled. If possible, the cause of overheating should be eliminated before starting up again.

The temperature increases as the pressure increases, therefore, it would be well to equip all air compressors with automatic pressure or temperature regulator, which will allow the compressor to run idle as soon as the pressure or temperature in the receiver reaches a predetermined limit and likewise bring the compressor into action again as soon as the pressure or temperature falls below this limit. There are regulators on the market which apply to compressors coupled direct to the engine, or driven by electric motors, or driven by belt and pulleys.

As an extra precaution, a fusible plug may be placed in the discharge pipe near the compressor. This plug should be constituted to fuse and blow out at a temperature of between 325 and 350 degrees F.

Remember that proper construction, proper care of the machine and high-grade lubricants, may save life and are cheaper than shut downs, lost power, destruction of property and damage suits!



A FUSIBLE ALARM PLUG FOR COMPRESSED AIR APPARATUS

The half tone above shows a fusible signal or alarm plug which requires practically no explanation to any one who reads the article immediately preceding. When everything is going all right in compressor, receiver and piping this device will have nothing to do but to stand and wait. Safety in compressed air practice is largely dependent upon the maintenance of normal temperatures. As is well known higher temperatures, with dangerous accompaniments, occur, and if not at once attended to explosions follow, or the air delivered is vitiated, with such consequences as that mentioned in the opening paragraph.

In the case where the man was killed by the products of combustion coming from (presumably) the air receiver, if this little plug had been on guard it would have given a warning whistle, the compressor would have been stopped and accident would have been averted.

In the use of this plug a ¼ in. pipe hole is drilled and tapped at the point or points where the high temperatures originate, the plug is screwed in and left there permanently and it will do the rest. The device contains a fusible insert which melts at a fixed predetermined temperature and when this temperature is reached, from whatever cause, there is a free escape of air which, rushing out of the holes in the cap, makes such a noise as compels immediate attention. When everything is all right again it is a simple matter to replace the fusible insert with a new one and the machine is again properly protected.

The melting points provided are 350 degrees and 500 degrees respectively. The first

of these is suitable for use in the discharge pipe of a single-stage compressor working up to 40 lb., in the discharge side of a two-stage compressor working up to 100 lbs., or in the discharge side of a three or four-tage machine delivering air at 1,000 lb.

The 500 degree plug is for use in the discharge pipe of a single stage compressor working at 100 lb.

Each plug is sent out with 6 extra fusible plugs or buttons and these can be supplied as numerously as required. The device is known as the Hodges Fusible Air Signal Plug. Ingersoll-Rand Company, 11 Broadway, N. Y.

APPLICATIONS OF THE SANDBLAST TO GOLD AND SILVER INDUSTRIES

BY FRANK MASON.*

The continued demand for variety in the finish and appearance of gold, silver, and electro-plated goods, gives to the sandblast such a wide field of operation as to be almost unlimited, and the opportunities, now opening up, for its application are without parallel in its history. As a ready means of imparting to silver and other surfaces, at a small cost, a finish, very pleasing to the eye, it is hard to rival. Sandblasting is by no means new, and has been in operation a considerable number of years, but its usefulness in the above mentioned direction would appear to have been either neglected or unnoticed in many manufactories, where it might be employed to great advantage. Its use, of course, is not merely confined to silver and gold, and when viewed from the broader field, its applications are extremely wide, being utilized for a number of purposes in the glass, china, iron and steel and other industries. No attempt, however, will be made here to describe its connection with these latter processes.

In contrast to the blasting required for gold and silver, that for iron and steel is very coarse and is applied very often for cleansing purposes. This, of course, would be totally unsuitable for the majority of articles plated with, or composed of the nobler metals. From the number of machines specially built for different classes of work, constantly being placed on the market, it would seem that blasting machine manufacturers are alive to the possibilities of their productions. These are now so numerous that to select the most suitable would be almost impossible without first being acquainted with the class of work to be done. In view of this fact, it is the intention of the writer to guide the would-be sandblaster in this selection, by a description of the conditions which exist when imparting to gold, silver and electro-plate a variety of finished surfaces. Briefly expressed, the process of sandblasting is one which consists essentially in forcing a stream of sand or other abrasive material against a metallic or other surface for the purpose of altering its characteristic appearance. The two chief governing factors of the process are, the pressure and the material used. Obviously, therefore, the method of procedure may be varied in two directions.

1. By varying the pressure used in forcing the blasting material against the article.

2. By using material with varying cutting properties and of different grain.

A matte may be obtained in the former case, which is very deep or slight, but not necessarily coarse, even under a pressure of 18 to 20 pounds per square inch. This factor (the power), then governs to a large extent the depth of the matte and varies between about 2 to 20 pounds per square inch, according to class of work, and desired ultimate appearance. The question of blasting material is one of undoubted importance and yet strange to say, is very often overlooked. It is not uncommon to find practical sandblasters of from 15 to 20 years' experience having used sand only and that in perhaps only two grades.

Some time ago it was the writer's privilege to visit two large English sandblasting works and in both cases the above mentioned conditions obtained, and the only means of imparting a relative fine or coarse matted surface was to increase or decrease the pressure. A visit to a continental plate and jewelry establishment would very quickly convince the sandblaster laboring under these conditions, of the obvious difficulties he would encounter in endeavoring to produce such surfaces as he would see displayed in a first-class house. The peculiarly frosted, delicate, French grey finish so dear to the artistic Parisienne, and to be seen all over the continent is a striking

*Assistant Demonstrator in Electro-Metallurgy, Department of Applied Science, University of Sheffield.

example of the careful manipulation and the delicate treatment necessary in some sandblasting operations. In this class of work this process is the last to which the article is submitted, hence its requirement of very careful treatment, judicious selection of blasting material and well regulated low pressure.

This finish is very often seen on silver toilet mounts and jewelry, but of course can be and is imparted to larger surfaces. The article, when ready is "Oxidized" by means of antimony chloride, relieved when necessary, and then blasted with finely powdered pumice at a pressure not exceeding 3 pounds per square inch. It will be obvious that to use a much higher pressure and coarse grained material would spoil the work put into the article just prior to this operation. The article is then washed out as if finished on the polishing wheel, or by hand.

Another instance in which very careful manipulation is required is in the production of the lovely, soft, greenish gold tint so much admired. This is obtained on gold-plated articles, as well as those manufactured wholly from the metal itself. Here again under even a moderate pressure from the sandblast, the deposit of gold would be completely spoiled. The method adopted in most cases to obtain the above finish is first to gild or gold-plate the articles, bringing them from the gold bath a little darker in color than is required in the finished appearance. If heavily coated, scratch brush, preferably with very fine German silver wire brush, and blast with flour of pumice under a pressure not exceeding 3 pounds per square inch. Wash away any pumice clinging to the article and wipe with very soft chamois leather. The resultant finish will be one which finds favor with the buyer of delicate jewelry, etc.

While discussing gold and gold-plated goods, it should be pointed out that almost all kinds of material used in blasting are also used in this connection. The difference in the above described process and those to which the reader is now referred being, that while in the former instances the blasting is the last operation, in the latter it is blasted just before being plated. In selecting the material and pressure to be used, the operator must be guided by the desired ultimate finish. For instance, in some cases a somewhat dull and exceedingly fine matted surface is required. A pressure of 8 to 10 pounds per square inch with finely divided pumice as blasting material will give this appearance. Then again, it is often required to produce on silver and gold a similar matte but bright. In this case substitute powdered glass for pumice.

A very fine surface appearance, usually employed on articles having parts in high relief, is obtained by means of the sandblast on "Oxidized" silver as follows:

The process of sandblasting should be operated just prior to silver plating using powdered pumice and a pressure of about 12 pounds. After completing the deposit, "oxidize" same in a solution of potassium sulphide until the article assumes a rich deep blue, or blue black color. Then by means of a calico mop or dolly and Trent sand, relieve where necessary according to design. The result of this process is quite a study in light and shade and is productive of some very fine effects. Satin finish, now often produced by means of the sandblast, is a term used to indicate the appearance of articles bearing a matted surface. This definition of the particular finish referred to, is perhaps the safest one to give on this occasion as the term is applied by different persons with "satin finish" ideas varying from coarse to very finely matted surfaces, and all grades between these two. The method which is found to be most satisfactory is to employ a pressure of about 14 pounds per square inch, using as blasting material a medium grain Calais sand, previously sifted. It may be well to mention that these conditions obtain in the majority of instances where table plate, etc., is required to have the matted surface throughout. The articles are then silver or gold plated by the ordinary method, if necessary.

Crystalline, ice-like surfaces similar to some molded glass wares, are sometimes desired. It is necessary in these cases to employ a high pressure, say 18 pounds per square inch. As blasting material, a coarsely ground glass or very coarse sand should be used. This, of course, is done before plating, and as it is quick and severe in operation must not be overdone by prolonged blasting. "Partial frosting," as the term suggests, is the production on one surface of a combination of matted and brilliantly burnished parts.

This gives to the article a very pleasing contrast and is imparted thereto by means of

the stencil. It may be accomplished very readily by cutting from ordinary writing paper or similar material the pattern or parts to be left bright or burnished, and then glue same to the article. Allow to set thoroughly, and sandblast unprotected portions. The glued paper is easily removed by suspending the article in hot water. Subsequent processes, such as plating, etc., may then be proceeded with.

To obtain the necessary pressure in all the foregoing operations, either compressed air or steam is used. In selecting the more suitable power for any specific work, it is well to bear in mind that if powdered pumice is intended for use steam pressure is out of the question, because, as the steam condenses it often impedes and eventually stops the action by clogging the course with wet pumice. Referring to the initial costs of the two systems, one is bound to say that steam pressure is the cheaper, generally. Of course, where compressed air is ready at hand, the above statement does not apply. If, however, matted surfaces much finer than the generally accepted satin finish is desired, then the operator will be well advised to install compressed air plant, although the cost may be greater.

MEASURING AIR DISCHARGE OF COMPRESSORS

BY E. A. FESSENDEN.*

This is a brief account of a method of measuring the volume of air delivered by a compressor which the writer has often successfully employed.

Only one tank is required and this may be the receiver tank which often forms a part of the compressed-air equipment. If such a receiver is not a part of the equipment, any reasonably tight tank will answer the purpose if it is strong enough to hold the normal delivery pressure of the compressor safely. A few small leaks will not affect the results in any manner whatever.

The arrangement of the tank is shown in Fig. 1. The outlet pipe contains a tee for a thermometer cup T and two valves A and B. A carefully calibrated gage is provided to read the pressure of the air in the tank. If the regular receiver is used the outlet pipe may be the ordinary service pipe, but when a test is to be made it must be disconnected from the service lines so as to discharge directly into the atmosphere through the two valves A and B. There should be a valve between the tank and the compressor. All other outlets from the tank should be closed off.

When ready for a test, first open valves A and B wide. Then with the compressor running at its usual speed gradually close valve B until the pressure in the tank remains constant at the normal working discharge pressure of the compressor. The compressor will then be running under normal operating conditions. After allowing the compressor to run in this condition for a short time to insure that all conditions have become constant, close valve A tight and allow the pressure in the tank to rise to 10 or 15 lb. above the normal working pressure. Then close the valve between the tank and the compressor and stop the latter.

Open the valve A quickly and take simultaneous readings of time and pressure as the pressure in the tank falls due to the escape of air through the valve B. The best way to do this is to have an assistant hold a watch and call "read" at uniform intervals of 15 or 30 sec. The exact pressure should be read at the instant the signal is called. Continue this until the pressure has dropped considerably below the working pressure.

Plot the readings just taken on cross-section paper so as to obtain a curve of pressure against time as illustrated in Fig. 2.

From the thermodynamics of gases we have the general equation for any gas,

$$PV = WRT \qquad (1)$$

in which

P = Absolute pressure in pounds per square foot;

V = Volume of gas under the pressure P, in cubic feet;

W = Weight of gas present in pounds;

T = Absolute temperature of the gas in deg. F.;

R = Constant = 53.35 for air.

Equation (1) can be rewritten as

$$W = \frac{PV}{RT} \qquad (2)$$

In the case under consideration W, P, V and T represent the weight, pressure, volume and temperature of the air in the tank at any time.

*Associate Professor of Mechanical Engineering, University of Missouri.

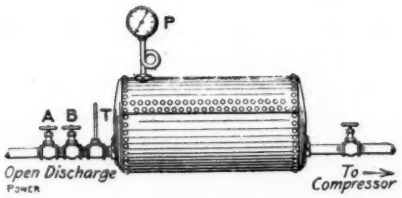


FIG. 1. AIR TANK FOR MEASURING DISCHARGE

The volume and the temperature remain constant and the pressure and weight decrease as the air escapes through the partly open valve B. The volume considered is the entire volume of the tank and all connections between valve B and the valve between the tank and compressor. This can be determined by filling the tank and connections with water, weighing the water required and calculating the volume by dividing by 62.355, the weight of 1 cu.ft. of water at 62 deg. F.

Differentiating equation (2) with respect to time gives

$$\frac{dW}{dt} = \frac{V}{RT} \times \frac{dP}{dt} \qquad (3)$$

in which $\frac{dW}{dt}$ is the rate of decrease of weight of air in the tank, or in other words, the rate of discharge, in pounds per second, while $\frac{dP}{dt}$ is the rate of decrease of pressure.

In Fig. 2 let M be a point on the pressure-time curve corresponding to the normal working pressure of the compressor. Draw the line MN tangent to the curve at M (this must be done carefully). Draw the line MK parallel to the pressure axis. Then

$$\frac{dP}{dt} = \frac{MK}{KN} \qquad (4)$$

The values of MK and KN are read in pounds per square foot and seconds directly from the figure.

If the value thus obtained for $\frac{dP}{dt}$ is introduced into equation (3) the rate of discharge in pounds per second is found directly. Since the weight discharged must be the same as the weight drawn into the compressor, the free air capacity is found by the formula

$$V_0 = \frac{WRT_0}{P_0} \qquad (5)$$

where V_0 is the volume in cubic feet of air per second at the intake pressure P_0 (in pounds per square foot absolute) and at the absolute temperature T_0, and W is the weight of air discharged per second just found from equation (3).

To illustrate this method consider Fig. 2 to be the pressure-time curve of a small compressor delivering air into a tank which with its connections has a volume of 47.7 cu.ft. The temperature of the air in the tank at the time the test was made was 87 deg. F. or 547 deg. abs. It was desired to find the amount of air discharged against a pressure of 56 lb. per sq.in. abs. Thus the line MK represents 56 lb. per sq.in. or 8064 lb. per sq.ft. From the figure KN is 194 — 20 = 174 sec. Then

$$\frac{dP}{dt} = \frac{MK}{KN} = \frac{8064}{174} \text{ lb. per sq.ft. per sec.}$$

From equation (3)

$$\frac{dW}{dt} = \frac{47.7}{53.35 \times 547} \times \frac{8064}{174} = 0.0758 \text{ lb. per sec.}$$

At atmospheric pressure and 32 deg. F. the volume of air passing into the compressor is

$$V_0 = \frac{WRT_0}{P_0} = \frac{0.0758 \times 53.35 \times 492}{14.7 \times 144}$$

$= 0.9391$ *cu.ft. per sec.* $= 56.346$ *cu.ft. per min.*

When accurate results are required, it is well to repeat readings for the pressure-time curve several times and take the average value of $\frac{dP}{dt}$

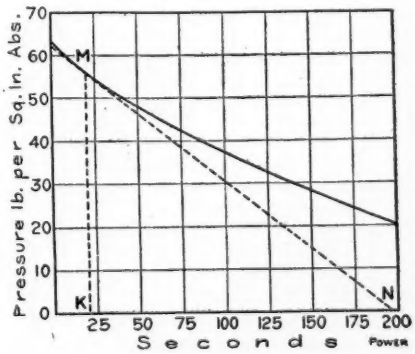


FIG. 2. PRESSURE-TIME CURVE

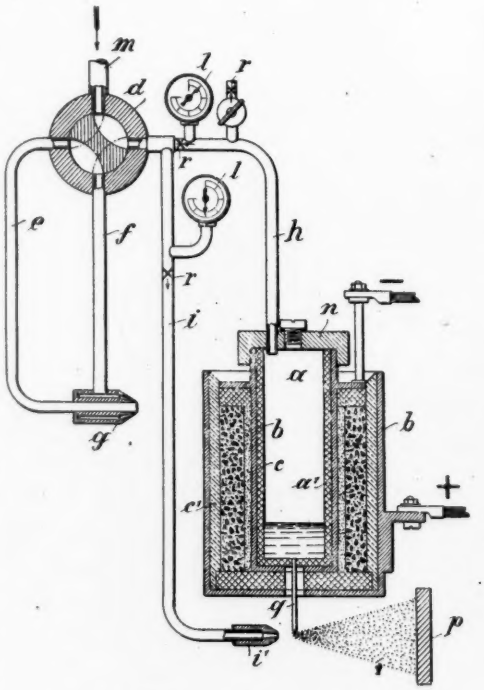
— thus obtained. It is, of course, important
dt
that the pressure gage and thermometer used be carefully calibrated, and that the temperature of the air remain the same when the readings for the pressure-time curve are taken as when the valve *B* is adjusted. After once adjusting valve *B* it must not be disturbed until the test is finished.

This same scheme can be used to provide a constant load on a compressor for an economy test. It is only necessary to adjust the valve *B* to give the discharge pressure desired and then run the compressor continuously at the proper speed, allowing it to discharge into the tank and the air escaping through valve *B*. As long as the pressure and temperature of the air in the tank are constant the rate of discharge is constant. The compressor governor should be adjusted to keep the speed constant and the pressure will remain constant as long as the valve *B* is unchanged. The temperature of the discharged air is practically dependent upon the amount and temperature of the jacket-cooling water. If these are kept constant the air temperature will not change appreciably. The compressor is then allowed to warm up thoroughly so that all these conditions become constant and the test is begun by adjusting valve *B*, thus fixing the rate of discharge as determined from a pressure-time curve. The load will now remain constant and the readings of steam pressure, steam weight, indicated horsepower, etc., are taken in the ordinary way.

The method outlined above has several advantages: It is rapid, simple, practically and theoretically correct and can be made very accurate if care is taken in making the readings and in plotting the pressure-time curve. It is flexible and can easily be adapted to widely different conditions of operation. All leakage and friction losses are taken into account. No expensive apparatus is required and often not even a change in piping. The manipulations and calculations are easy.—*Power.*

SPELLERIZING

For small sizes of pipe a process. known as "spellerizing" has been developed by the National Tube Co., to give a uniformly dense surface to steel piping adapted to resist corrosion and pitting. This process consists in running the heated bloom through rolls, having projections on their working surface, then running the bloom through smooth faced rolls and repeating the operation, thus kneading the surface and compacting it. The process is applied to pipe 4 in. and under, although it can be used in special cases for pipe a few sizes larger than 4 in.

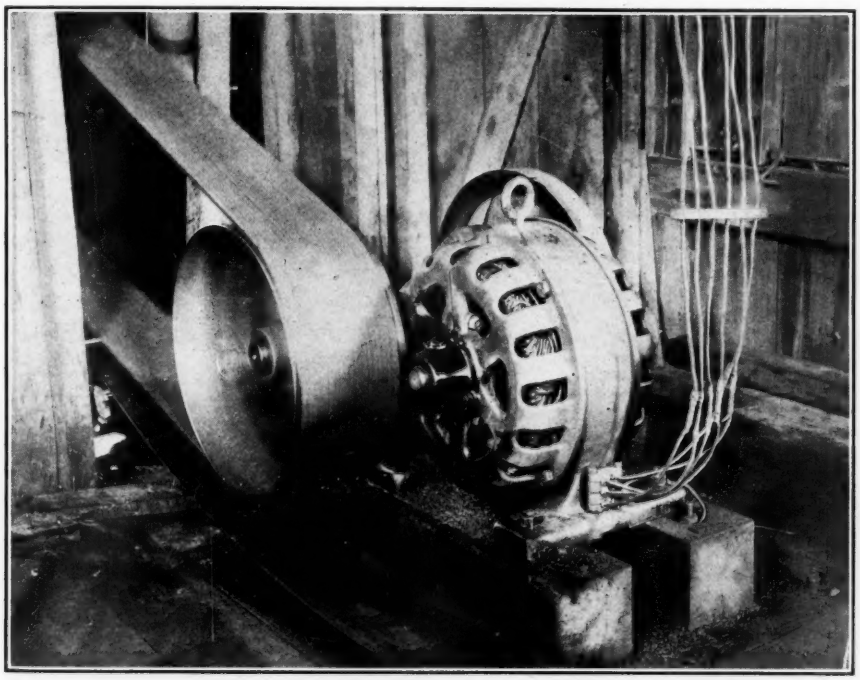


MAKING METAL POWDERS

The cut is a sketch of an arrangement, recently patented in France by M. Schoop, for producing powders of metals, such as lead, tin, zinc, etc. The metal to be powdered is melted in an electric crucible a, flows out through the small tube q, and as it emerges it is struck by a forcible blast of air from the nozzle i^1 and driven against the plate p, this operation reducing the metal to a fine powder.

Compressed air is responsible for the entire operation. The air is led from the compressor by pipe m. With the four-way valve d in the position shown there is air pressure upon the surface of the molten metal in the vessel a, and air also flows down pipe i to the nozzle i^1. The valves r provide the means for differentiating the pressures in the two pipes, that for the blowing nozzle being required to be the greater. Upon the

proper adjustment of these relative pressures much of the success of the operation may depend. When the four-way valve is turned to the position shown by the dotted lines compressed air flows through pipe c to the ejector g, which creates a partial vacuum in pipe f, which then communicates with pipe h and the vacuum not only holds up the metal in crucible a, but draws it up so that it will not solidify in pipe q.



TWO-SPEED MOTOR FOR FAN DRIVE.

A TWO-SPEED A. C. MOTOR FOR A MINE FAN DRIVE

The halftone illustrates a special adaptation of electricity to mine service. It shows a two-speed alternating current, three-phase, 60 cycle, 440 volt motor belted to a 12 foot Guibal fan installed in the Greensburg No. 1 mine of the Keystone Coal Company.

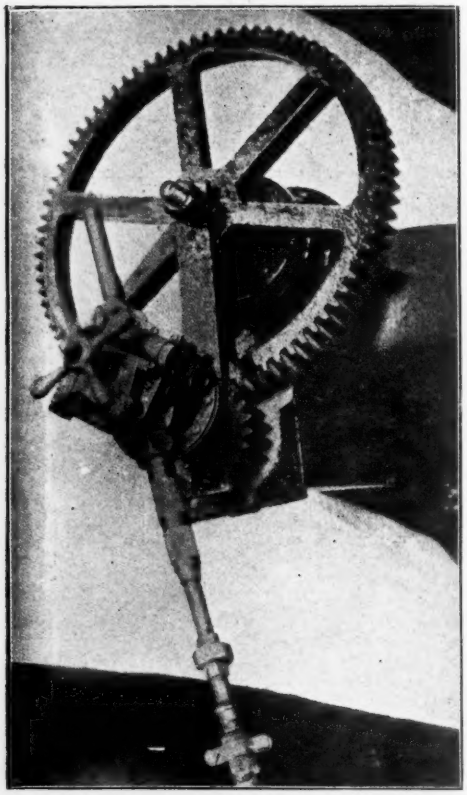
The force of miners is considerably less at night, and consequently it is then desired to run the fan at only about half the speed. To satisfy the requirement there was selected a Westinghouse CCL squirrel-cage type induction motor with a rating of 7½ horsepower at 600 rpm. and 15 horsepower at 1,200 rpm.

The change in speed is accomplished by changing the number of poles. The stator of the motor is provided with two windings, one of which gives 6 poles with a speed of 1,200 rpm., and the other 12 poles and 600 rpm., the connections from one set of windings to the other being made by the controller. The motor can thus be operated at the low speed at its highest efficiency, there being no losses in the control resistance.

Current for the operation of this motor is furnished by the West Penn. Electric Company. To determine the results tests were made by Mr. C. V. Elliott, electrical engineer of the Lighting Company.

The fan is 5 feet, 6 inches wide, and the blades 3 feet, 6 inches deep. When running at 120 rpm., with 1.5 inches water gage, 46,200 cubic feet of air per minute were delivered. The motor took 9.6 kw., giving an efficiency of 63.03 per cent. When running at half speed, or 60 rpm., with .8 inch water gage, 14,850 cubic feet were delivered with an efficiency of 58.53 per cent These

results are important as they show economy in the use of purchased power, which is becoming the standard practice where alternating current is available.



AIR MOTOR FOR WATER GATE.

OPERATING GATE VALVES BY COMPRESSED AIR

A compressed air motor equipment for operating large valves in water mains, shown in accompanying illustration, is used on four large valves in the Sacramento waterworks, and, it is said, will open a valve in 2 minutes where it formerly took two or three men 10 minutes. The size of the gear, which meshes with a 4-inch pinion, is 24 inches.

This device was invented by Louis D. Ehret, chief engineer of city waterworks, Sacramento, Cal. It may be attached to a valve with little difficulty and used for opening and closing it. The valve shown in the illustration is a 30-inch suction valve of the 10,000,000 gallon Snow pumping engine.

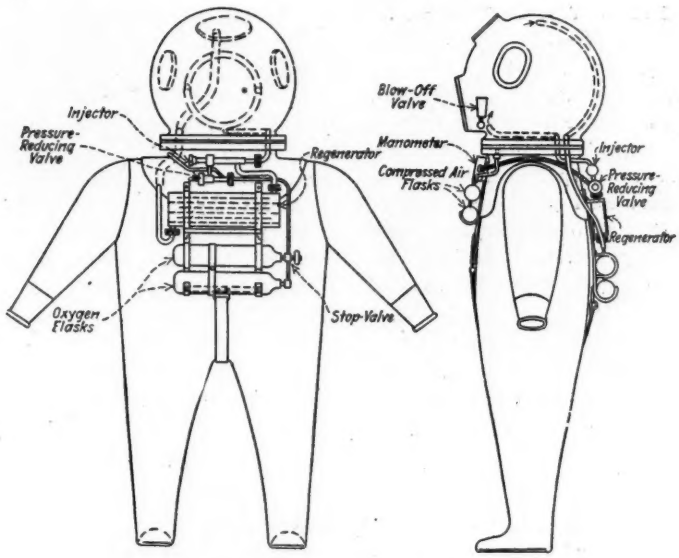
Engineer Ehret first intended to operate the valve with an electric motor, but it was found that the expense of the motor and power would be too high. He then changed the power to compressed air.

As there is an 8-inch pump operating in the plant to fill the air chambers on the pump, all that was necessary to do was to install a receiver and rig up the gears. With this arrangement the opening and closing of the large valve is performed in a most satisfactory manner, besides being a great saver of time and hard work.—*Insurance Engineering.*

[The above is interesting, but the device has scarcely the novelty here claimed for it. Many gate valves in the water service of New York City are operated by compressed air motors of the "Imperial" type. Editor C. A. M.]

AIR SHOULD BE COOL AS WELL AS "FRESH"

Prof. J. B. Lock gives some interesting particulars of experiments that have been carried out at Cambridge during recent years in connection with the heating and ventilation of large lecture rooms and halls. Various system have been tried, and have led to the conclusion that a crowded room should not be warmed by heated air; the fresh air supplied for breathing should be cooler than the air in the room, and the room should be warmed by other means. A large hall seating 1,000 persons is heated with hot-water radiators near the walls at the floor level, and fresh air is introduced by fan through two rows of gratings 8 ft. or 9 ft. above the floor level; an exhaust fan withdraws the air through openings in the ceiling. Two years' observation has established the fact that the cooler the fresh air sent in, the more pleasant is the atmosphere in the hall; when the hall is full it is difficult to obtain air cool enough, even when the outside temperature is 40 deg. Fah., and the installation of ice coolers is under consideration. In the case of laboratories warmed by hot air, which is passed over heating pipes, the oppression and discomfort experienced by the occupants are much greater when steam heating pipes are used than in the case of hot water pipes, and it appears that "cooking" fresh air destroys its invigorating qualities.



SELF-SUPPLYING DIVING APPARATUS.

AN INDEPENDENT DIVING APPARATUS

For this abstract here presented we are indebted to the Foreign Review department of the monthly Journal of the American Society of Mechanical Engineers. It is taken from *Glückauf*, Sept. 7, 1912.

By invitation of the German Navy Office several firms have endeavored to construct a *diving apparatus without air pipe*, such as might be used by the crew of a submarine in case of accident. The present article treats of one by the Westfalia Armaturen- und Maschinenfabrik in Gelsenkirchen, Germany. Both factories had, previous to the consruction of diving apparatus, a large experience in the manufacture of similar apparatus for miners and firemen. As shown in the cut the diver carries on his back a regenerator tank taking care of carbon dioxide and water vapor from breathing, while below it are steel flasks with gas for breathing. This gas is not pure oxygen, which is poisonous when at high pressure, but a mixture of oxygen and compressed air in such proportion that even at a depth of 50 m (164 ft.), corresponding to a pressure of 6 atmospheres absolute, the content of oxygen does not exceed 23 per cent. Various ratios of the mixture are used for work at various depths; thus, for 20 to 30 m (65 to 98 ft.) 45 per cent. oxygen and 55 per cent. nitrogen, while for depths from 50 to 60 m (164 to 196 ft.) 30 per cent. oxygen and 70 per cent. nitrogen. The oxygen and air or nitrogen are not kept in separate vessels, but the flask is first filled with compressed air up to a certain pressure, and the oxygen is then pumped in, special tables being used for the determination of the pressure corresponding to certain percentages of oxygen in the mixture. The pressure-reducing valve between the steel flasks and injector is so arranged as to vary automatically the amount of gas admitted in proportion to the water pressure, the diving outfit being thus always filled and permitting of easy and comfortable breathing. The compressed gas mixture serves also to drive the injector which, with the help of suitably arranged piping, takes the vitiated air from the upper part of the helm and returns it thither after it has passed through the regenerator and becomes free of the carbon dioxide and moisture. On the front side are placed two flasks with compressed air, to be used for rapidly filling the diving suit when the diver wants to come to the surface quickly. The manometer permits him to see what supply of air and oxygen he still has at his command.

THE PNEUMATIC TIRE WITHOUT A RIVAL

BY J. D. ANDERSON *

It used to be the fashion among inventors to periodically announce a new and deeper probe into the abysmal depths of the mystifying problem of perpetual motion. To do this was considered good style. Obviously styles change among inventors as well as among ordinary mortals. Just at present they appear to have dropped perpetual motion like a hot potato. What they're now trying to figure out is a substitute for air and rubber in the manufacture of automobile tires.

These days it's a poor inventor indeed who hasn't concealed about his person a blue print drawing or a working model of a patented wheel or tire that is destined to knock the everlasting daylights out of tire trouble. A few thousand or so patents covering such inventions have been issued by the United States Government. Promoting companies by the score have been formed; with persistent frequency startling announcements regarding the efficiency of some new discovery in the patent wheel line are scattered broadcast. And yet, with the automobile in a state of development approaching perfection, no one has been able to invent anything that could satisfactorily and permanently take the place of air and rubber.

The reason for this is that in their own particular line air and rubber are doing about all any reasonable person could expect them to do. Many experts, thoroughly conversant with every detail of the situation, maintain that the automobile never will rest satisfactorily on any other footing. Others, perhaps equally well informed, are not so sure that this is a fact. But of one thing we are all sure. That is that up to the present time nothing practical has been created to supplant such a highly resilient substance as rubber in conjunction with compressed air, in providing a foundation for the motor car.

The duties of an automobile tire are more exacting than the casual observer may imagine. Perhaps the first quality to be taken into account is that of endurance. A tire must be so constructed and made of such materials that it will yield a satisfactory milage return on the cash investment. This question of mileage service is the one which appeals with particular force to the car owner. However, there are other tire essentials, which, while probably not so conspicuous, by their presence, would be decidedly conspicuous should they be eliminated by the tire manufacturer.

Resiliency is an important feature of the pneumatic tire. This is the quality that absorbs the shocks of the road, furnishing easy riding not only to passengers, but protecting the engine and mechanism of the car as well. Without resiliency, a tire cannot perform some of its most important functions, and the whole structure of the motor car suffers in consequence. It is in the lack of this element of resiliency that most of the patented substitutes for air and rubber fall down. For easy riding and for affording complete protection to all parts of the car pneumatic tires, at least up to the present time, stand supreme.

The tires of an automobile must withstand all the force and impact of the engine in starting, driving, and stopping the car; they must carry weight, resist wear, withstand the heat generated by friction with road surfaces and the resistance of the brakes in stopping the car. Futhermore, they must be so constructed as to permit of quick removal and ready substitution. All of these qualities pneumatic tires, as they are made under our advanced methods of manufacture, possess. The only argument against them is that they will puncture and they will wear out. However, no substitute has yet been offered which combines all of the advantages of the pneumatic tire with greater lasting qualities at less cost.—*Evening Post,* New York.

*General Sales Manager United States Tire Co.

APNEUMATIC INCIDENT

Bennie, aged 4, met Henry, aged 5, and the following conversation ensued:

"Whatsamatter your head?"

"Bumped it ona ceiling."

"Ona stepladder?"

"No, I was playin' 'ith my papa on a floor an' I was sittin' on his tummy."

"An' nen what?"

"Papa sneezed."

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - Managing Editor
CHAS. A. HIRSCHBERG, - Associate Editor
F. C. IGLEHART, JR., - Business Manager
W. C. LAROS, - - Circulation Manager

PUBLISHED BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XVIII. FEBRUARY, 1913. No. 2

CONTENTS

Electric Drives in Iron Mining..... 6699
A New Blower..... 6703
Various Waters 6704
Protecting the Sand Blast Operator.... 6705
Tests of a Turbo Compressor..... 6705
Various Pneumatic Devices..... 6706
The Farmer's Blower..... 6708
Counterbalanced Deep-Well Pump..... 6709
Care of Air Compressors..... 6710
Fusible Alarm Plug..... 6711
Sand Blast in Gold and Silver Industries 6712
Measuring Discharge of Compressor.... 6714
Spellerizing 6716
Making Metal Powders..... 6716
Two-Speed Motor for Mine Fan..... 6717
Air Motor for Water Gate..... 6718
Independent Diving Apparatus..... 6719
Pneumatic Tire Without a Rival..... 6720
Compressed Air Elevating the Foundry.. 6721
Saved Dollars—Lost Lives..... 6722
Negligent Compressed Air Practice..... 6722
Air Blast Caused by Mine Collapse..... 6723
Air Lift Experience..... 6724
Notes 6725
Patents 6727

COMPRESSED AIR ELEVATING THE FOUNDRY

It is a curious fact that progress in mechanical industry does not proceed according to any well established laws, but that it seems to act in an irregular manner, some departments of work lagging behind, while others keep in the lead.

It has always been a matter for surprise that the foundry, until recently, has failed to keep pace with the machine shop, and even to-day it is only in the more modern and better equipped shops that the department in which the castings are made is as far advanced as the department in which those same castings are finished.

To-day, however, the foundry is overtaking the other departments of the manufacturing establishment, and there is every reason to believe that the modern workshop is more nearly homogeneous than ever before, so far as character of equipment is concerned. The moulding machine, the overhead traveling crane, the industrial railway, the pneumatic rammer—these and other tools are fairly equal in capacity and value to the lathe, the planer and the milling machine.

When we consider the interdependence of the various departments of a manufacturing establishment, it seems strange that modern equipment did not enter the foundry earlier than it has. The study of the influence of each element in a series of operations in sequence has emphasized what was well known before, even if imperfectly appreciated, that the final efficiency is found by multiplying together the several efficiencies of the successive operations. Since the product of the foundry entered into nearly all the other departments of an establishment, it is evident that an inefficient foundry formed a serious handicap upon all the departments which it served, so that any improvement effected could not fail to be far-reaching in its influence.

There is probably no one element which has aided more in the advancement of the efficiency of the foundry than compressed air. Whether in the operation of machines for ramming moulds, for operating hoists, for serving moulding machines, or for cleaning castings, the presence of a supply of air under pressure has placed in the hands of the foun-

dryman a source of power which has worked both for effectiveness and for economy.

Foundry work does not differ materially from other work in the extent to which the work of the brain may be supplemented by mechanical power. The skill of the hand is not inseparably connected with severe muscular exertion, although in many cases manual effort cannot be replaced acceptably by machinery. What can be done, and what is most effectively done by the use of compressed air, is to provide for the skilled hand such auxiliary power as will require only direction, and yet be at all times under perfect control.

Herein lies the demonstration, if demonstration be necessary, of the extent to which machinery which saves burdensome labor acts also to create further opportunities for skilled labor. When there is a greater demand for labor of a higher degree of skill, and when this demand is created by the introduction of apparatus which enables productiveness to be increased, we see that the ultimate effect of such appliances is to make more labor possible, while at the same time raising its character.

It is worthy of note that in operations in which mechanical power is substituted for manual effort the result is generally superior in quality to that formerly obtained solely by hand labor. This is doubtless due to several influences: the force at command is greater than could be exerted by the unaided hand, in addition to which the relief of the hand from the exertion of its full effort enables greater care to be given in guiding and regulating the mechanical power.

SAVED FEW DOLLARS—LOST THEIR LIVES

At Quincy, Mass., on January 1, at the granite yard of Reed & Vendret, an air receiver exploded causing the death of Mr. Reed and his brother-in-law, Mr. Lavoie. Some particulars of this "accident" have come to hand. The receiver was 6 ft. long and 4½ ft. in diameter, and had been in service at this yard five years. From its dimensions we are inclined to doubt whether it was originally built for an air receiver at all. It was bought second-hand with presumably the assurance that it was all right. It had previously stood upright for holding creosote. As an air receiver it was used horizontally. What had been the bottom head began to leak in one place near the rivets. Four holes were drilled and a plate was put on inside and out, after which the air was pumped up to 75 lb., and then the explosion occurred, the plates being sheared from the head and doing the killing. The head, near where it is dished, ripped open about 18 in. and showed the bottom to be deeply pitted, these pits being about 1 in. in diameter, so that ¼ in. metal plate in one place showed a thickness—say rather a thinness—of $^1/_{16}$ in.

This receiver was cheap in the beginning, if such a thing could be cheap at any price, but it was dear enough in the end. An air receiver should be one of the last things to buy second-hand, especially if its entire record cannot be known. Regular air receivers, especially those for the little plants, begin their existence with a minute factor of safety at the best. They are said everything cold and quiet, but as soon as to be tested by hydrostatic pressure with they get into service they may become very hot and subjected more or less to shock and where is that factor of safety then? The conditions of service favor the rapid rusting of the interior and rust is not a strengthening agent.

We have a brief account of another receiver explosion in Tennessee, as follows: "The shell of a 24x72 in. air receiver, carrying 90 lb. pressure, split from end to end in a straight line when the metal had wasted away to $^1/_{16}$ in. in thickness, at the end where the rupture started." An hour before the explosion occurred this receiver could have been regarded as an excellent subject for a second-hand dealer to offer as a bargain.

NEGLIGENT COMPRESSED AIR PRACTICE

A paper having to do with air compressors and compressed air practice was read recently before the Manchester Association of Engineers by Mr. George Barr. The paper was offered with the idea of considering the reason why compressed air is accepted as an inefficient means of power transmission, as well as to show what had been done by manufacturers to improve this class of machine without any considerable pressure having been brought to bear on the subject by users. The author said that very inefficient plants exist, and exist in

large numbers, and are still being laid down. Why was this? Was it simply because it is thought nothing but inefficiency can be expected? Why not have the same strict specification applicable to air compressing plant as has been the rule for electric generating plant? The only reason which can be put forward why such a course was not adopted, would seem to be, taking a wide view of the matter, that few engineers had given much study to compressed air, and had taken it for granted that what had been, must still continue. We might look at the matter from this standpoint and see if the facts are as indicated. What did we find, in inquiries issued for large compressors? The capacity of machine was given, if steam driven, steam pressure and vacuum mentioned, if electrically driven, voltage. It might be, but it was not general, that steam consumption was asked, and on a very rare occasion a capacity test was called for. Such a test when made was seldom, if ever, any check on the output of the machine; the test generally being to fill a reservoir of given capacity from atmospheric pressure to final working pressure. The temperature of the air might be taken or might not, and when taken was generally misleading, and possibly allowed of error up to 10 per cent. It was questionable whether there was one compressor the actual capacity of which was known through a test.

UTILIZATION OF ATMOSPHERIC NITROGEN

The importance of nitrogenous compounds to the agricultural and industrial interests of Europe and America has prompted the Bureau of Manufactures to issue a monograph on the subject of utilizing atmospheric nitrogen in the production of such compounds.

The nitrogen problem, one of the most pressing of the twentieth century, is unique from the fact that the material is unlimited. The atmospheric nitrogen above one square mile of land, amounting to about 22,000,000 tons, is equivalent to what the world would require in the next fifty years at the present rate of consumption. The problem is to utilize this nitrogen economically, and thus free the world from its dependence on the nitrate deposits of Chile, which are not particularly extensive and are likely to be exhausted at a comparatively early date.

Remarkable results have been obtained in Norway by means of electric furnaces in which atmospheric nitrogen is oxidized to the form of nitric oxide, which is used in making calcium nitrate, or Norway saltpeter. This Norwegian product is already an important rival of Chile saltpeter, but as the success of the process depends upon a very cheap supply of electricity it will probably not be used to any great extent in the United States until the furnaces have been made more efficient.

Cyanamide, another nitrogenous fertilizer of growing importance, is being manufactured in America and the industry should prove successful, as the production in this country of the calcium carbide required by the process is second only to that of Norway.

The monograph describes in detail the results obtained by the leading European chemists in their efforts to increase the supply of nitrogenous compounds, and the commercial as well as the technical aspects of the new industry are dealt with at length. The author, Thomas H. Norton, consul at Chemnitz, Germany, on detail as commercial agent of the Department of Commerce and Labor, states in conclusion that the achievements of applied chemistry make it possible for American industry and agriculture to face with confidence the threatened exhaustion of the nitrate deposits of Chile.

TERRIFIC AIR BLAST CAUSED BY MINE COLLAPSE

The chief inspector of mines in India gives the following account of a destructive air blast which occurred recently at the Dhundabad coal mine of the Manbhum Coal Company:

A violent blast, produced by an extensive fall of roof, dislodged a rail 11 ft. 6 in. long and weighing 52 lb., hurling it a distance of 32 ft. In its flight it struck a woman on her head and killed her outright. She was engaged in filling a car at the time when the roof fell.

The accident serves to bring into prominence the serious consequences to life and to the value of a mine which almost inevitably follow the leaving on "first working" of such small pillars that their ultimate crushing strength is but slightly greater than the pressure exerted by the weight of the superincumbent strata.

In a part of the mine where the cover varied

from 100 to 150 ft. and was composed of alternating shales and sandstones, the seam had been cut up into pillars some years ago. At the time of the accident these pillars ranged in size from 100 ft. square to 30 ft. square by 18 ft. high.

Pillar drawing had recently been started and 19 pillars had been extracted in the usual manner, when weighting of the roof began to assert itself in a mild form. The mine workers in that section were withdrawn and every precaution taken to protect those in other parts of the mine from being exposed to the effects of a sudden and dangerous development of this condition.

After the lapse of a fortnight a change took place and imminent collapse seemed certain. All the workers were removed from that side of the mine and told to work on the other side of No. 1 pit, 700 ft. away. This order was obeyed. That night the roof over the extracted area collapsed and so strained the adjoining roof that the pillars under it, numbering 103, were unable to withstand the added pressure and gave way, causing the roof to subside over an area of about 160,000 sq. ft. (four acres) and affecting the surface over a smiliar area, which resulted in damage being done to 57 huts.

Many persons in the mine were blown over and all the lamps were extinguished with the exception of one, by the aid of which the people found their way to the surface. Two men, sitting under the protection sheets of the shaft bottom, had a narrow escape.

Extensive pillar robbing had been practiced in the past and had so reduced some of the pillars that it was not safe to take them out. The fact that they had been much reduced in size assisted in the general collapse.

Large areas have been mined out in other parts of this mine. The subsequent falls have been confined to these areas and have not extended over the standing pillars. This, no doubt, led the manager to assume that the weight would be similarly restricted in this case also. The event, however, is one more proof that when pillars of small size are being drawn, sudden subsidence over an area exceeding the area extracted should be anticipated, and in such cases, all persons should be ordered out of the mine when the roof begins to show signs of collapse.

AIR LIFT EXPERIENCE

The company with which the writer is connected has, during the past seven or eight years, had in operation on the Pohle system 14 wells of an average depth of about 250 ft. These wells are in sand, interspersed with lenses of rather fine gravel. Some of the wells have 4, others 5, and others 6-in. discharge pipes, each having a 1¼-in. central air pipe. The water is found about 75 ft. from the surface, but, owing to the fine sand and gravel through which it must pass, there is considerable drop when the wells are pumping, the amount of drop depending upon the quantity of water pumped.

The lift at the different wells varies from 100 to 140 ft. Various submergences or heads have been tried from 60 to 35 or 40 per cent. of the total head and lift. The wells being in almost constant use in connection with the works have made the conditions very unfavorable for conducting a series of experiments or tests that would be of any particular value, but it is hoped that in the near future a favorable opportunity will offer.

As a means of obtaining a sufficient supply of water the wells have been a success, but from an economical standpoint per gallon of water pumped they have not been entirely satisfactory, and for this reason the writer some years ago undertook to work out theoretically the principles involved in the operation of the wells with the view of establishing the proper conditions for the most economical results. Formulas were deduced for determining the proper relation of head, lift, quantity of water, diameter of discharge pipe, quantity and pressure of free air required, etc., with the expectation of confirming or disproving them by actual test, but so far, for the reason stated above, without result.

In an article recently noted the following occurs: "Size of discharge pipe, gallons of water delivered per minute and ratio of lift to submergence remaining constant, the free air required per minute will be the same regardless of whether the lift is 10 or 100 ft."

This is at variance with theory, with the practice of engineers in figuring free air requirement, and also with the actual experience of the writer. Under the conditions as stated engineers figure the free air required would be proportional to the lift. Theoretically, the

free air required does not increase proportionally with the lift. The statement that "the cubic feet of free air per gallon of water raised increases as the ratio increases for a given size of discharge pipe, and for a given ratio it decreases as the size of the discharge pipe increases," agrees with theory. Also the free air required per gallon of water decreases with increased submergence, the lift remaining constant.

The statement that "a curve representing the horsepower per gallon of water raised for varying depths and constant lift will at first decrease as the depth increases until it reaches a minimum point, after which it increases" is not in accordance with theory. Theoretically, commencing at 10 per cent. submergence, the horsepower of the air required increases by a constantly decreasing ratio for each percentage of increase in the submergence. Economy in horsepower, therefore of fuel, lies in the direction of lower percentage of submergence, while economy in size of compressor plant, piping, etc., lies in the direction of increased percentage of submergence up to, say, 60 per cent.

For any given well the submergence, lift and quantity of water discharged being known, the proper diameter of discharge and air pipe may be found, and the whole adjusted to the most economical working condition.—*Iron Age.*

FILTERING AIR FOR CYANIDE PLANTS

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is passed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, whch are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

NOTES

Consular Reports says that 35 million pounds of matches were exported from Sweden in six months. Why, that's 17,500 tons!

Nitrogen amounting to 810,000,000 tons has been wasted in the United States since 1893 through the use of the old-fashioned beehive coking oven. By-product coke ovens would have yielded from this coal 9,315,000 tons of ammonium sulphate, worth $60 per ton, which could have been used as a fertilizer instead of importing $15,000,000 worth of potash from Germany every year.

Steam is about three-fifths as heavy as common air. An atmosphere of pure steam would exert a pressure of a little more than nine pounds per square inch; yet the water, from which the steam is generated, is 770 times heavier than air. To the above, from an exchange, it might be added that while air is heavier than steam the liquid from which it is "generated" is about 6 per cent. lighter than water.

A railroad of many tunnels, aggregating one-fifth of the total length of the line, has been opened by the Paris-Lyons-Mediterranean Company from Morez to Sainte-Claude, in the French Alps. The line, in a total length of about 24 km. (15 miles), has eighteen tunnels, representing about 20 per cent. of the entire length, the longest being 1,750 m (more than a mile) long. There are also nine viaducts, the longest having nine spans.

The University of Tennessee has just instituted extension courses in geology especially designed for men engaged in the mining and quarry industries. The courses consist of a short session (six weeks) and correspondence work. The subjects of instruction will be: Physics, chemistry, math-

ematics, geology, mining and metallurgy, and mechanical engineering. The courses are described as especially adapted to meet the need of the man "on the firing line."

One of the highest altitudes recorded by aviators was reached at Hendon, December 16th, when Mr. Sydney Pickles reached a height of 7,200 ft. The Australian airman went up in a Caudron biplane, and was in the air between twenty and twenty-five minutes, when the figure referred to was indicated on his barograph.

The new funicular railway from Lucerne to Dietschiberg, known as the Little Righi, has been opened to traffic. The line is 1,400 yds long, and the cost of construction was about $70,000. It will be one of the most popular ascents in Switzerland, as the view from the summit, over 2,000 ft. above sea level, is magnificent, including many famous peaks of the Bernese-Oberland.

The recent successful application of a propeller working in the air as a means of propulsion both for a road vehicle and for a canal barge has been followed by some interesting experiments by French officers in Algiers with a kind of sledge mounted on six wheels, driven by a 50-horsepower motor, and similarly equipped with a propeller. This vehicle, which carries three persons, travels easily over the rolling sand at a speed of 12 to 18 miles an hour, and is said to be able to climb gradients of one in five.

The Cumbler Estate has installed a large new steam drill at their limestone quarries near Steelton, Pa. This will be used in drilling holes six inches in diameter through the limestone rock to a depth varying from 75 to 125 feet. These holes will then be charged with an improved blasting powder, and a battery of such holes will be fired simultaneously. Each blast of this kind removes from the face of the limestone cliff a mass of rock estimated to weigh from 40,000 to 60,000 tons. Owing to the scarcity of laborers at the quarries a large steam shovel has been installed to facilitate the loading of the blasted stones on railroad cars.

Think of a boiler shop of the present day without anything pneumatic. Consular Reports in an account of the state railways of the Dutch East Indies and of their several shops gives among other things the equipment of the boiler shop at Bandeong. They have the usual modern machine tools: electric traveling crane, plate planer, plate straightener, bending rolls, shear, drills, punches, *but* "Compressed air is not used in any part of the works, the management having found that the Javanese workmen are not strong enough to use air hammers properly. Consequently all riveting, caulking, and chipping is done by hand."

At the mines in the vicinity of Battle Mountain, Nevada, the scarcity of water has made it necessary to use it as sparingly as possible. The water is made to circulate through the jackets of the gas-engine and compressor naturally, thus eliminating the trouble and expense of pumps. A large water tank is placed beside the engine and beside the compressor. The water enters the cooling jackets at the bottom. It quickly becomes heated, and as it consequently becomes lighter it rises from the jacket up through the discharge pipe and enters the water tank near the top, the water-level being always kept above the discharge.

The Rio de Janeiro Tramway, Light & Power Co. has a monopoly for supplying the city of Rio de Janeiro with light and power, the power being derived from the falls of Rebeirao das Lages, about 50 miles from Rio de Janeiro, where there is now a plant generating 50,000 horsepower, and 30,000 more horsepower is being added to this station. The reservoir at Lages impounds 204,000,000 cubic meters of water, and in order to keep the level of the water in the reservoir as near constant as possible the company is constructing a tunnel 9 kilometers (5.59 miles) long from the Pirahy river to the reservoir at a great cost. The tunnel will be completed in July, 1913.

An underground river was pierced, on December 23, by the advance heading of the tunnel which is being driven through the Cote d'Or Mountains, in France. The stream of water pierced by the advance heading was of such volume and pressure that

the workmen in the tunnel barely escaped with their lives. Cable dispatches from Berne, on December 28, stated that the flow from the tunnel had increased in volume since it was first pierced and had swelled the rivers in the vicinity to a dangerous extent.

As many as 72 war aeroplanes lined up in a recent review of the French air fleet. Every machine was ready to take to the air, the commanders, pilots and observers standing at attention in front of the machines during the inspection. After a brief and businesslike review by the war minister, machine after machine rose and flew away, 20 of them leaving for posts on the eastern frontier.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sendingn five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 3.

1,045,853. SINTERING-FURNACE. MILTON HENRY KAUFFMAN, Denver, Colo.

1,045,918. PNEUMATIC FRICTION-CLUTCH. JAMES A. VIELE, Warren, Pa.

1,045,931. VACUUM-CLEANER. EDWARD M. BARNES, Hastings, Mich.

1,046,090-1. PNEUMATIC SPRING FOR VEHICLES. RICHARD LIEBAU, Watervliet, N. Y.

1,046,145. PNEUMATIC LIFTING-JACK. WILLIAM BUDESHEIM, Brooklyn, Md.

1,046,164. BLOWER-OPERATED WHISTLE. PETER J. FANNING, Providence, R. I.

1,046,303-4. MEANS FOR REMOVING AIR AND NON-CONDENSED STEAM FROM VACUUM APPARATUS, CONDENSERS, AND THE LIKE. EMIL JOSSE and WILHELM GENSECKE, Charlottenburg, Germany.

1,046,308. METHOD OF AND MEANS FOR GENERATING POWER. JOSEPH MOSES WARD KITCHEN, East Orange, N. J.

1. In a steam generating plant, the combination with a boiler of, (1) means comprising a gas generator and an air compressor for generating a combustible gas under a controlled forced air pressure, (2) means for and a place for admixing air for combustion with the combustible gas, said place being located apart from where the gas is generated, and (3) means for securing the burning of the admixed gas and air at the place where the gas and air are admixed, said burning being performed under a controlled forced pressure and under a controlled back pressure.

1,046,311. HYDROPNEUMATIC DRILL. COLUMBUS K. LASSITER and FRANK E. BOCORSELSKI, Richmond, Va.

3,492. VALVE SYSTEM AND TRACKER-BOARD. HARRY PIERCE, Kansas City, Mo.

DECEMBER 10.

1,046,585. FLUID-ACTUATED CLUTCH. THEODORE A. HAAKONSON, Jelly, Cal.

1,046,522. METHOD OF BLOWING SOOT. THOMAS E. WHITE, Philadelphia, Pa.

1. The method of cleaning soot from boiler surfaces which comprises carrying heating gases over the surface to be cleaned and simultaneously discharging a fluid over a portion of said surface in opposition to a section of said gases without opposing a remaining section thereof, so that the dislodged soot shall be carried into the unobstructed section of said gases.

1,046,603. INJECTOR VACUUM-PRODUCER. FRANK KENNEY, Troutdale, Oreg.

1,046,610. ORGAN-PIPE ATTACHMENT FOR AUTO-PNEUMATIC PIANOS. WILLIAM ARNETT KUPP, St. Johnsville, N. Y.

1,046,706. WINDMILL. JESSE F. YOUNG, Northport, Neb.

1,046,716. PROCESS OF COLORING PINEAPPLES. LEWIS E. ARNOLD, Honolulu, Hawaii.

A process for coloring light colored pineapple which comprises sealing the peeled pineapple in a suitable container, evacuating the container *to withdraw the air* or gases from all the pores or cells of the fruit and admitting to the evacuated container a syrup of refined cane sugar and water which enters all the pores or cells of the pineapple and so affects its properties as to immediately change the color of the pineapple.

1,046,767. DESICCATING APPARATUS. JOHANN MICHAEL GABLER-SALITER, Obergunzburg, Germany.

1,046,861. FEEDING DEVICE FOR PNEUMATIC TOOLS. BURTON C. SANDERSON, HARVEY D. PALMER and ALLEN R. HODGES, Topeka, Kan.

1,046,884. MEANS FOR CLEARING THE PIPES OF PNEUMATIC SYSTEMS. IRA H. SPENCER, Hartford, Conn.

1,047,127. OIL-BURNER. ERASTUS A. HODGE, Spokane, Wash.

DECEMBER 17.

1,047,250. BURNER. JOSEPH LEO LANDRY, Napoleonville, La.

1,047,268. CUSHION-WHEEL. JOHN MILLAR, Arlington, N. J.

1,047,352. AUTOMATIC AIR-HOSE COUPLING. WILLIAM A. WEIL, Findlay, Ohio.

1,047,370. PROCESS OF DISINTEGRATING MOLTEN SLAG. JOHN G. BERGQUIST, Chicago, Ill.

1,047,409. PNEUMATIC-TIRE PUMP-COUPLING. REGINALD F. HERSEY, Beverly, Mass.

1,047,487. PNEUMATIC CLEANER. EDWARD M. BARNES, Cleveland, Ohio.

1,047,489. HYDRAULIC APPARATUS. HENRI BEAU, Paris, France.

A hydraulic apparatus comprising a vertical pipe adapted to contain a column of liquid; upper and lower chambers formed at the lower end of the pipe and forming a continuation thereof; gratings in the sides of the lower chamber; yieldable membranes covering the outer face of said gratings; pockets covering said membranes; an air reservoir communicating with said pockets; means for forcing downwardly said column of water against the pressure of the membranes and the air of the air reservoir, whereby the column is caused to rebound; a clack valve at the upper part of the pipe for permitting the efflux of the water when the column rebounds; and means for holding the clack valve closed when the column is being forced downwardly.

1,047,495. PNEUMATIC WHEEL. ARTHUR BURFOOT and JASPER BURFOOT, Auckland, New Zeeland.

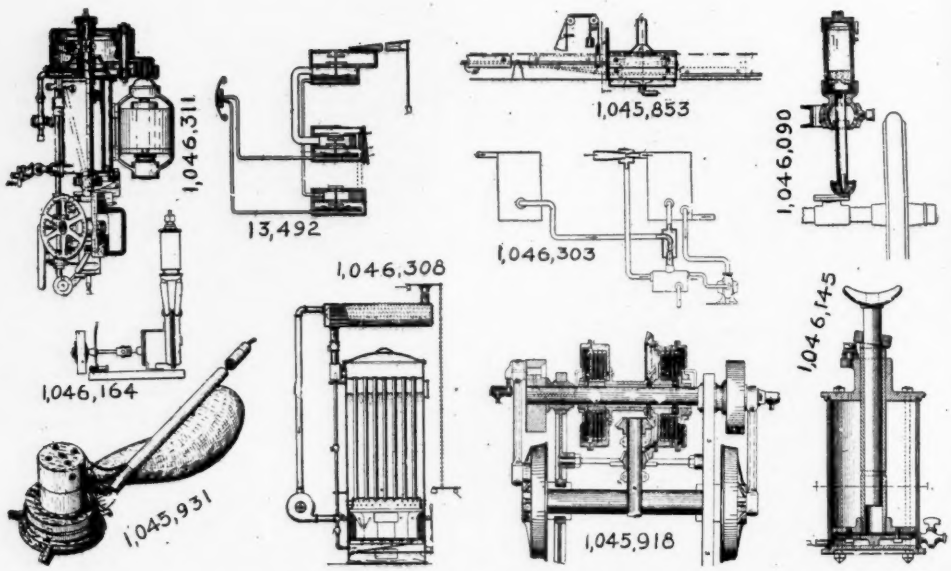
1,047,532. PNEUMATIC HAMMER. WILLIAM S. JOHNSON, Berwick, Pa.

1,047,547. PNEUMATIC CARRIER. REINHOLD MEIER, Chicago, Ill.

1,047,585. VACUUM-PUMP. GRAY STAUNTON, Evanston, Ill.

1,047,590. AIR-ADMISSION DEVICE FOR LOCOMOTIVE FIRE-BOXES. JOHN G. TALMAGE, Cleveland, Ohio.

1,047,620-1. PNEUMATIC WHEEL. JAMES M. DENNIS and RUSSEL R. DENNIS, Cambridge City, Ind.



PNEUMATIC PATENTS, DECEMBER 3.

1,047,636. CEMENT-MIXER. FRANK C. HORN, Boise, Idaho.

1,047,663. TURBINE COMPRESSOR OR PUMP FOR ELASTIC FLUIDS. FRANZ LAWACZECK, Aerzen, near Hameln, Germany.

1,047,706. FLUID-ACTUATED GONG. GEORGE R. W. ROBERTS and HARRY HOOPES SEELY, Alameda, Cal.

1,047,726. PIPE-CLEANER. ANTHONY J. YOGGERST and LAWRENCE G. YOGGERST, Springfield, Ill.

1,047,765. AIR PURIFYING AND HUMIDIFYING APPARATUS. GEORGE C. DERBY, San Francisco, Cal.

1,047,826. PROCESS OF OXIDIZING FERROUS TO FERRIC SOLUTIONS. ALEXANDER MCKECHNIE, Birmingham, and FREDERIC GEORGE BEASLEY, Smethwick, Birmingham, England.

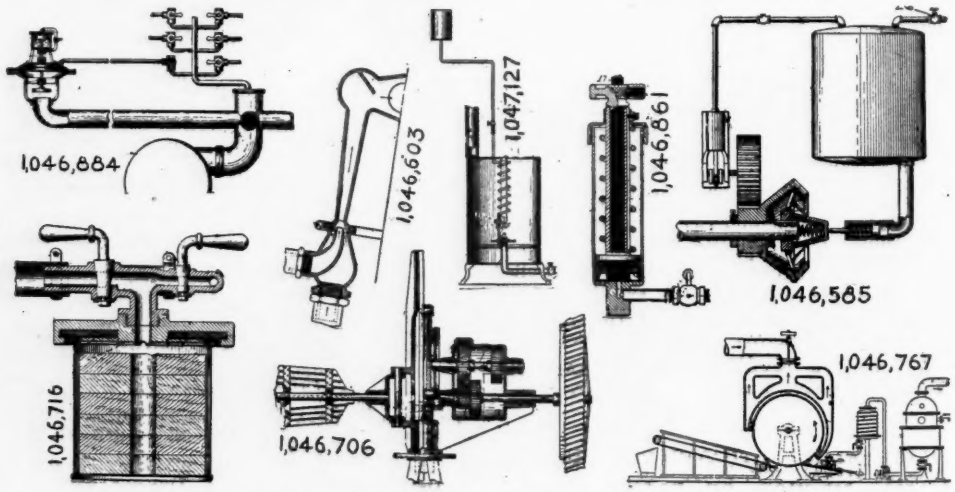
A process for the manufacture of ferric solution by the direct oxidation of ferrous solutons, consisting in treating such ferrous solutions, in a closed vessel, with air which is blown or forced into the said vessel to maintain therein *a pressure exceeding atmospheric pressure* while the solutions are also heated above their boiling point, substantially as described.

1,047,836. CONTROLLING-GEAR FOR STEAM OR OTHER FLUID ENGINES. HENRY PILLING, Lancaster, England.

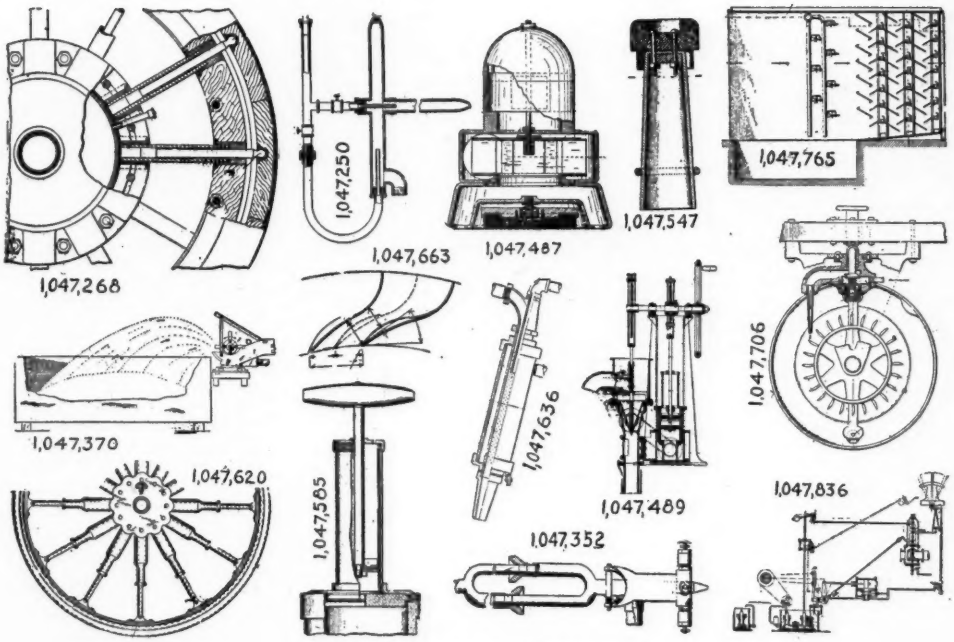
DECEMBER 24.

1,047,911. METER FOR STEAM, AIR, OR OTHER GASES. GEORGE HALE BARRUS, Brookline, Mass.

1,047,959. BLOWER-UNLOADING DEVICE. JAMES G. MACLAREN, Weehawken, N. J.



PNEUMATIC PATENTS, DECEMBER 10.



PNEUMATIC PATENTS, DECEMBER 17.

1,047,977. VARIABLE-CAPACITY COMPRESSOR. BRUNO V. NORDBERG, Milwaukee, Wis.

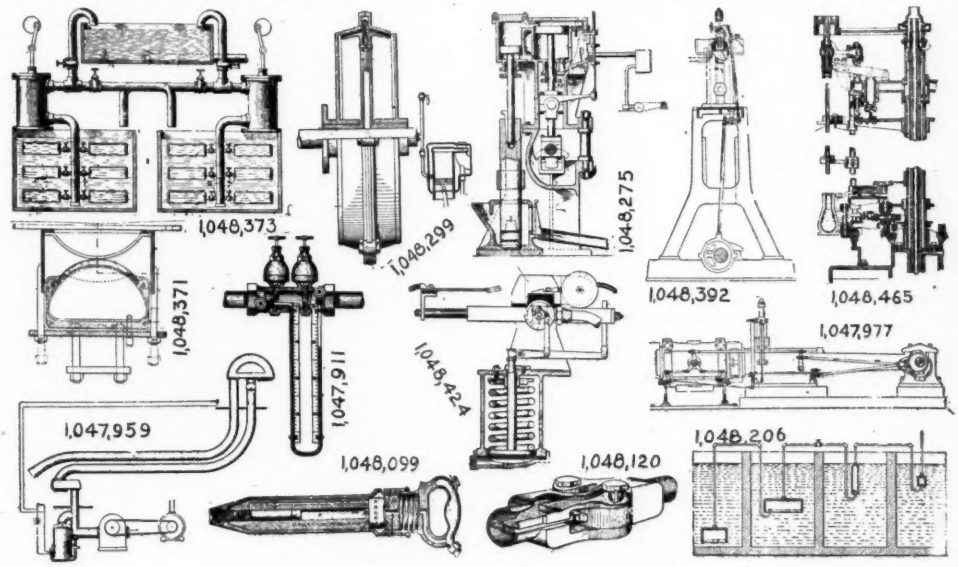
1,048,009. VACUUM-CLEANER. JOHN VOGELZANGS and FRANK E. MORGAN, Green Bay, Wis.

1,048,099. PNEUMATIC HAMMER. GEORGE L. ROBERTSON, Philadelphia, Pa.

1,048,120. AUTOMATIC AIR-COUPLING. JAMES C WRIGHT, Kansas City, Mo.

1,048,206. AIR-FLUSHING APPARATUS. ALBERT PRIESTMAN, Philadelphia, Pa.

1. In apparatus for the purpose described, the combination of an air-pipe having a liquid-seal, a hydrostatically controlled air-bell communicating with said air-pipe, a sealed pressure accumulator of larger size than said hydrostatically controlled air-bell inclosing the liquid seal of said air-pipe, an air-pipe leading from said accumulator and having a liquid seal, a sealed receiver inclosing the liquid seal of the air-pipe leading from said accumulator, and a delivery



PNEUMATIC PATENTS, DECEMBER 24.

pipe for the flushed air leading from the receiver.

1,048,275. PNEUMATIC PERCUSSIVE MACHINE. Hans Charles Behr, Johannesburg, Transvaal.

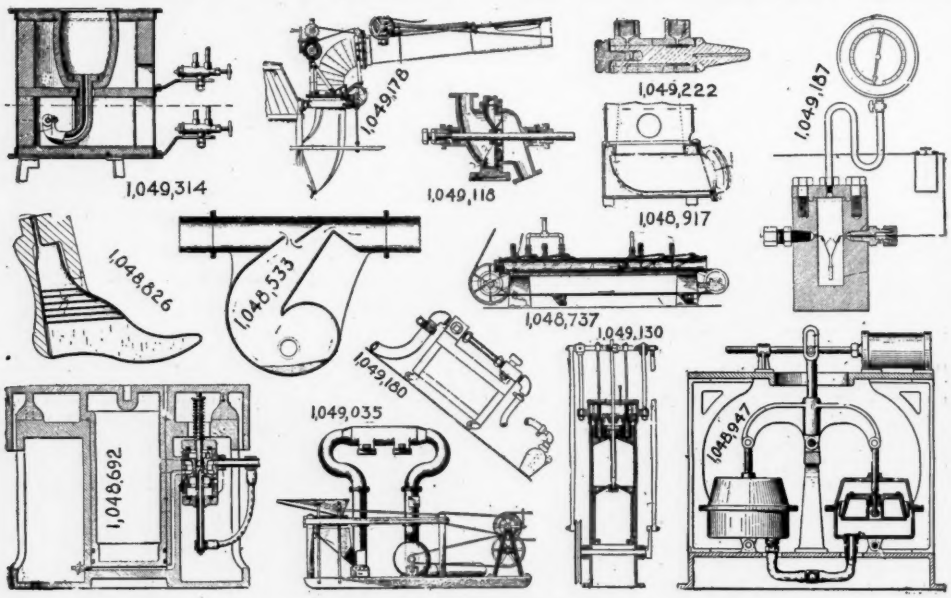
1,048,299. PNEUMATIC CLUTCH, James T. Dickson, Los Angeles, Cal.

1,048,301. PNEUMATIC JACK. Louis J. Dittmar, Louisville, Ky.

1,048,371. PNEUMATIC CUSHION-SPRING FOR WHEELED VEHICLES. Joseph William Sutton, Brisbane, Queensland, Australia.

1,048,373. APPARATUS FOR PRECIPITATING VALUE-BEARING SOLUTIONS. Whitman Symmes, Virginia City, and Walter E. Trent, Reno, Nev.

1. An apparatus for the precipitation of cyanid solution for the recovery of metal values therefrom, the same comprising a receiving vessel for the solution, a suction pipe extended



Pneumatic Patents, December 31.

therefrom, a vacuum pan or tray containing a filtering medium and a fixed bed of precipitant arranged in advance of the filtering medium, connection between the vacuum pan and the suction pipe, and means connected to the suction pipe for drawing the solution from the receiving vessel through the fixed bed of precipitant within the vacuum pan.

1,048,392. AMMONIA-COMPRESSOR AND VALVE-OPERATING MECHANISM THEREFOR. James H. Dennedy, Detroit, Mich.

1,048,424. FLUID-PRESSURE GOVERNOR. Joseph F. Menningen, West Allis, Wis.

1,048,465. GLASS-BLOWING MACHINE. Cornelius J. Nolan, Toledo, Ohio.

DECEMBER 31.

1,048,486. PNEUMATIC PIANO. William G. Betz, Chicago Heights, Ill.

1,048,507. AUTOMATIC ELECTRIC AIR-BRAKE. Edward H. Dewson, New York, N. Y., and Walter V. Turner, Edgewood, Pa.

1,048,533. GAS-SEPARATOR. Louis A. Hoffman, Jr., Leetonia, Ohio.

1,048,615. VALVE FOR PNEUMATIC PIANO-PLAYERS, ETC. John A. Weser, New York, N. Y.

1,048,692. VALVE FOR IMPACT MOLDING-MACHINES. Clarence M. Henderson, Berkeley, Cal.

1,048,737. VACUUM-PUMP AND AIR-COMPRESSOR. Robert A. Sallee, Middletown, Cal.

1,048,812. PROCESS OF MANUFACTURING OXYGEN. Henry L. Doherty, New York, N. Y.

1. In the manufacture of oxygen from a peroxid the method of heating the peroxid which comprises re-heating a portion of the oxygen evolved from the said peroxid and contacting the said re-heated oxygen with the said peroxid.

1,048,826. PNEUMATIC BOOT-TREE. August Hermann Max Grune, Pirmasens, Germany.

1,048,931. PNEUMATIC-DESPATCH APPARATUS. Thomas Bemis, Indianapolis, Ind.

1,048,917. VACUUM CLEANING SYSTEM. Frank W. Van Ness, Milwaukee, Wis.

1,048,947. PUMP FOR VACUUM SYSTEMS, Harry B. Cornish, Minneapolis, Minn.

1,049,035. CONCENTRATOR. Frederick M. Atkinson, Chicago, Ill.

1,049,118. CENTRIFUGAL AIR-PUMP. Georges Massip, Paris, France.

1,049,130. VACUUM-PUMP. Aleksander Morawski, Warsaw, Russia.

1,049,178. PNEUMATIC STACKER. Edward J. Vraalstad, Buffalo, N. Y.

1,049,180. APPARATUS FOR HANDLING GRAPE-JUICE AND OTHER FLUIDS. Frank J. Walker, Jr., Erie, Pa.

2. In an apparatus of the character described, a fluid receiving tank, means to exhaust air therefrom, an automatic valve therein adapted to be operated by the fluid level in said tank to stop the flow of air from said tank, a fluid supply pipe leading into said tank, and a valve in said supply-pipe, substantially as set forth.

1,049,187. PRESSURE-INDICATOR. James H. Wilson, Ashland, Pa.

1,049,222. ACETYLENE-OXYGEN WELDING-TORCH. John D. Frear, Centerville, Kan.

1,049,306. SAFETY AIR-BRAKE VALVE. Frank T. Jones, Baltimore, Md.

1,049,314. APPARATUS FOR ATOMIZING METALS. James Millar Neil, New York, N. Y.